SEP 12 1957

Design Engineering

FIVE DOLLARS A YEAR

Spectrography...59

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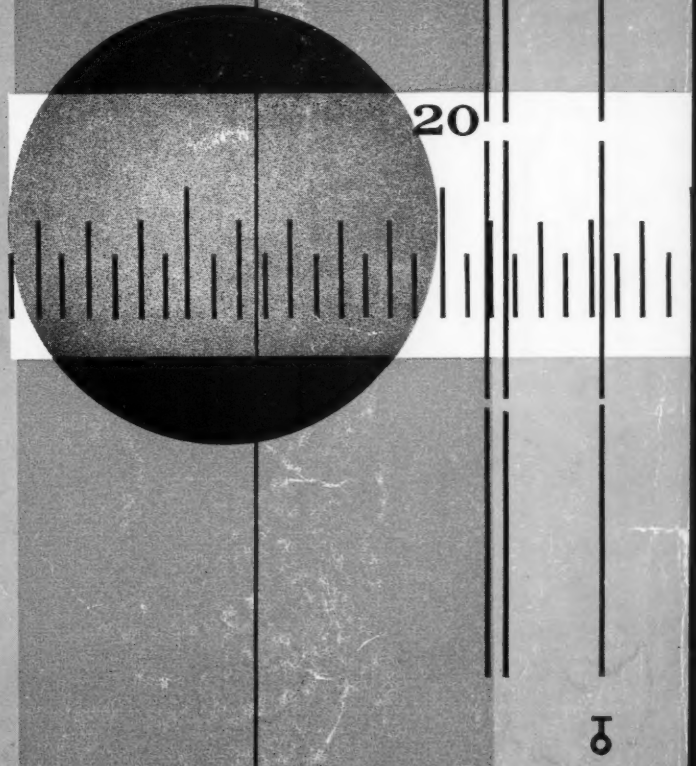
High temperature microscopy. 51



September 1957

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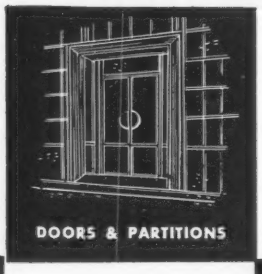

DOORS & PARTITIONS

CURTAIN WALL CONSTRUCTION

DUCTWORK

CANOPIES
LOUVRES
SUN SHADES

STORE FRONTS

SANDWICH WALLS

HANDRAILS

HARDWARE
(Door Pulls, Kick Plates)
THRESHOLDS
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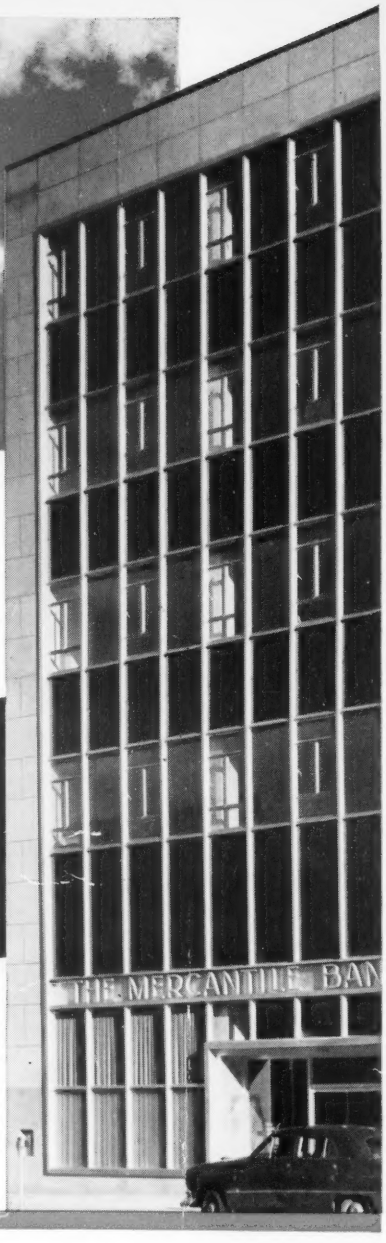

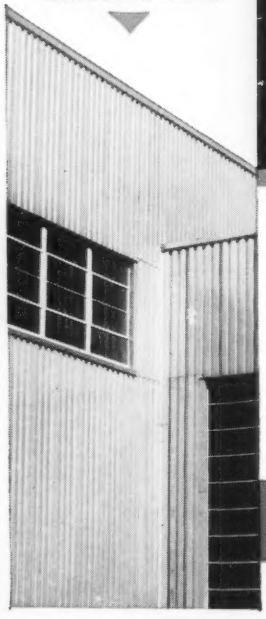

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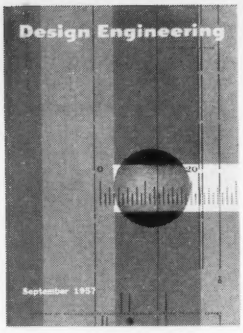

Design Engineering

Vol. 3 SEPTEMBER 1957 No. 9

This month's cover

Newcomer to Design Engineering's band of cover artists is Tomas Kessler whose work adorns the September issue. Kessler, who used to work in Montreal, is now based in Calgary and did the cover, you might say, on the way through. His work illustrates a densitometer screen which can be seen in its unglamorized version in our feature article on spectrography.

Design Engineering

MEMBER

CCAB

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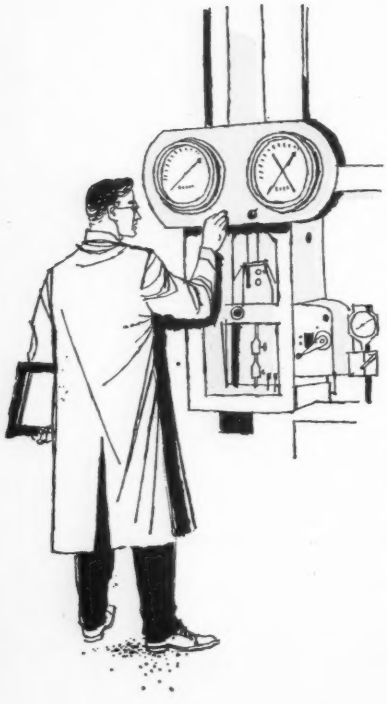
SHAWINIGAN STAINLESS STEEL



Why does industry demand 'Shawinigan' Stainless Steel when it wants castings of the highest quality?

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Inside

Hersey

Vice-president of the Warnock Hersey Co. Ltd., **E. Peter Hersey,** is a professional chemist and author of our testing article (X-ray testing spreads wide its new wings). He is also a member of the ASTM, the Chemical Institute of Canada and the National Society of Corrosion Engineers. He has directed the development of his company's department of non-destructive testing since its inception in 1953, a department that handles X-ray, ultrasonic, gamma ray and fluorescent dye penetrant methods.

Majka

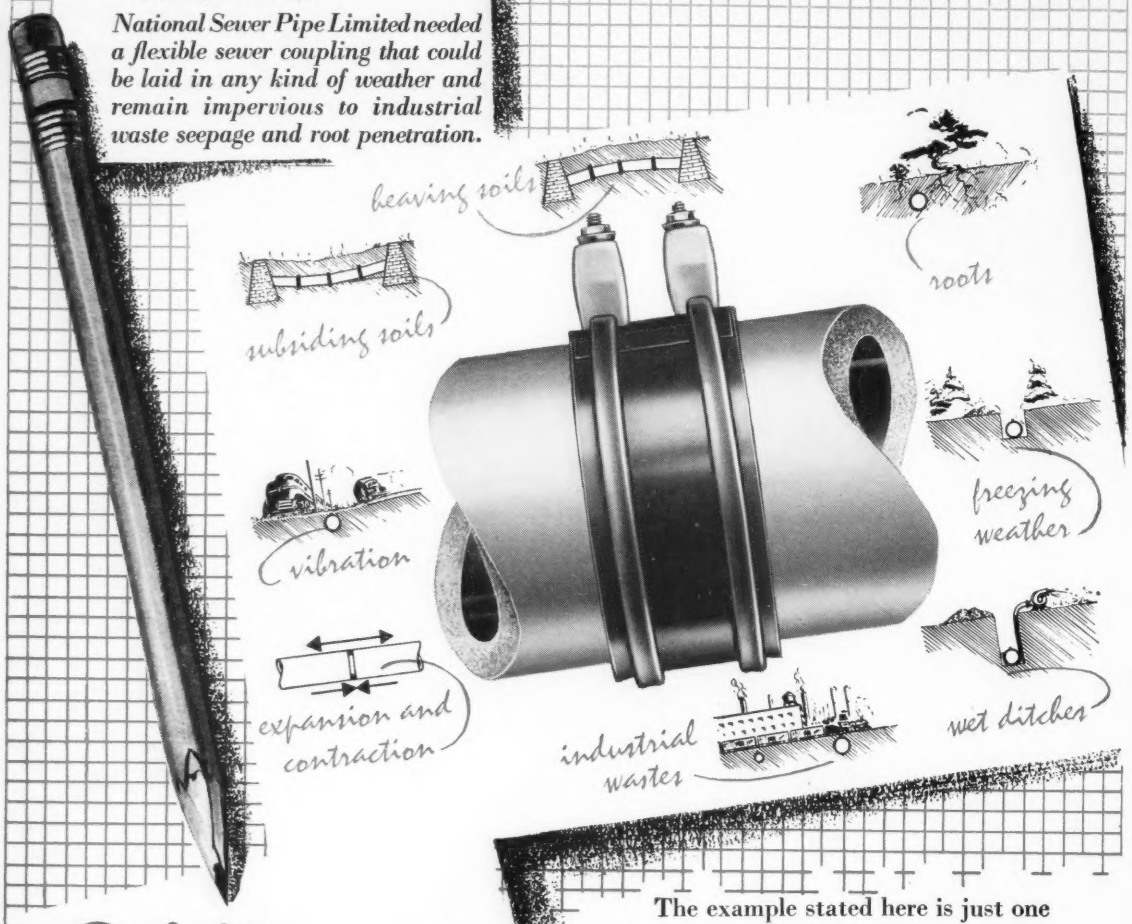
Polish-born **S. J. Majka** (Taking a close look at hot materials) attended the Technical University of Iowa, graduating as a diploma engineer in 1937. He left the university as assistant lecturer in 1938 and joined Lublin Aircraft as chief research engineer. During the war he worked with Devoitine Aircraft until the fall of France and then joined the Polish forces in Britain. He worked in that country up to 1948 when he came to Canada and the Ontario Research Foundation. He is a Research Fellow.

Linkert

Warren Linkert (Science's chemical element detective) once played lead trumpet in a Hamilton dance band and is trying to live down a brief fling at singing, a musical career cut short by graduation and a three year stint with Eldorado Mining in Port Hope. He is now with Westinghouse as supervising chemist in charge of the analytical section of the research and development laboratory. He is an ardent skier, a handyman to a new home, "almost wins prizes" at badminton and tinkers with a "temperamental car."

Problem

National Sewer Pipe Limited needed a flexible sewer coupling that could be laid in any kind of weather and remain impervious to industrial waste seepage and root penetration.



Solution

They chose Polysar Butyl 301. This special type of Polysar has high resistance to ozone, water, heat and cold—remains constantly flexible—and gives a pressure-tight fit unaffected by either sewage or soil attack.

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If you have a technical problem it may well be that Polysar synthetic rubber holds the best answer. Write to our Sales and Technical Service Division, Polymer Corporation Limited, Sarnia, Canada.

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NOTHING PERFORMS LIKE RUBBER — *The best buy for your money*

Reports

News in brief from the world's producers

New Monicker
One of Canada's best known instrumentation firms has changed its name and will now be known as **Canadian Applied Research Limited.** It was formerly known as PSC Applied Research Limited.

Canadian Applied Research Limited was recently incorporated into the group of companies owned by **A. V. Roe Canada Limited.**

Metal Cutting
The Ontario section of the **American Society of Lubrication Engineers** will be holding a meeting in Robert's Restaurant, 747 King Street East in Hamilton on Tuesday, September 10.

The program will consist of a panel discussion on metal cutting conducted by four experts. There will be, as usual, a question period and people are invited to bring along their problems and try to stump the experts.

All guests are cordially welcome. The bar opens at 5:30 p.m., dinner is at 7 p.m. and the meeting starts at 8 p.m. Price of the dinner is $3.25.

Anyone interested should contact W. H. Mann, at Canadian D. A. Stuart Oil Company Limited, 3575 Danforth Avenue, Toronto 13.

Everybody's in Hi-Fi
Judging by the state of the phonograph market, more and more Canadians are becoming music aficionados.

Sales of hi-fi sets so far this year are running about 50% ahead of last, and should reach a new record, according to **RCA Victor.** This company also reports a steady upsurge of interest in stereophonic sound, the next step beyond high fidelity in recorded music.

Fire Fighting
We note from a Toronto newspaper that the city is interested in a new British pump for Civil Defense fire fighting.

This 380 lb. portable pump cost $1,700 compared with $2,600 for the conventional fire engine like those used by the city fire department. The pump is a development of the **Coventry Climax** model which was written up in Design Engineering in the May 1955 issue.

Interruption-Free
More than $1 million worth of **Canadian Westinghouse** electrical equipment, including the world's largest installation of magnetic-amplifier controls, have been installed at **Dominion Foundries and Steel Limited,** Hamilton. The apparatus was installed piecemeal over a period of six months without major interruption to steel mill operations.

Canucks "Down-under"
From Wellington, New Zealand, comes news that the contract for four 56,000 h.p. hydraulic turbines for the Roxburgh Power Station has been awarded to the **Dominion Engineering Company** of Montreal. The Roxburgh Power Station is located on the Clutha River in New Zealand's South Island and is the largest power development in the Dominion.

Montreal Show
The **Canadian Material Handling Show and Conference** which will be held in Montreal's Show Mart, September 30 to October 4 is building up to one of the largest industrial shows ever staged in Canada. Mid-summer bookings indicate that the show will be the biggest trade exhibition yet put on in Montreal.

Film Listing
Design Engineering's list of films for a comprehensive technical film index is still growing. You are invited to send details of films available from your company to the Editor.

Arrow Soon?
Chances are that the public will get its first peek at Canada's CF-105 (or the Arrow) very shortly.

This delta wing design from **Avro Aircraft** at Malton will take its power from twin Iroquois jet engines. An interesting statistic which we picked up on the Arrow somewhere concerned the plane's control mechanism which "will be powerful enough to move an elephant weighing four tons through 40° on the end of a 15 foot pole."

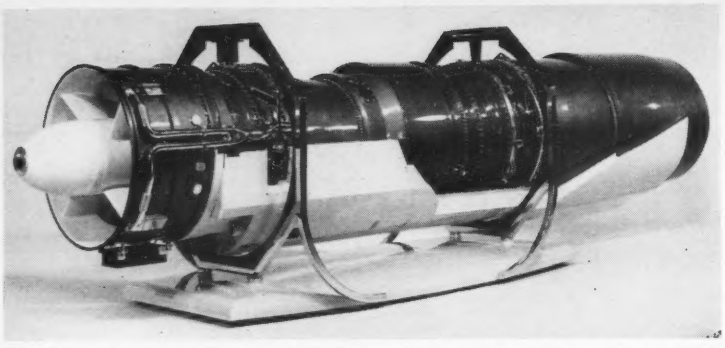
Some Sapphire!
A scientific break-through in the growing and fabrication of large sized industrial sapphire discs was announced recently by **Linde Company.** The company's laboratories have produced a clear crystal disc, five inches in diameter. Before this advance in manufacturing techniques, the largest disc grown was about three inches in diameter. There is a picture at the bottom of this page.

Troubled Britain
British engineering products add up to nearly half of her exports. The struggle for the markets of the world against intense competition is the main preoccupation of British engineering chiefs who feel that only one thing can defeat them — price.

Recently they agreed to a rise in engineering wages on condition that the unions did not put in another claim for a year. Hardly was the ink dry on the agreement when the unions put in a demand for the working week to be reduced from 44 to 40 hours. Technically, this is not a wage claim.

Practically, it would cost the engineering industry 150 million pounds a year.

Quantity production of the monster sapphire is planned for the near future.



The Iroquois can operate at temperatures close to the melting point of gold.

Lubrication Engineers
Engineers interested in lubrication will hear and discuss the results of research projects at the fourth lubrication conference jointly sponsored by the **American Society of Lubrication Engineers** and the **American Society of Mechanical Engineers.** The meeting will be held at the Royal York Hotel, Toronto, on October 7, 8 and 9, this year. It is expected that this year's conference will outdo last year's meeting at Atlantic City which was attended by 400 engineers from all parts of the United States and Canada.

Inventors to Brussels
Canadian inventors have been given an open invitation to exhibit their ideas at the **International Inventors Exhibition** at Brussels in 1958. The invitation was given in Toronto recently by the 38-year-old president of the exhibition, Paul Quintin, whose one warning was "Crackpots keep out!"

The Iroquois
By now, everyone has read in their newspapers about **Orenda's** new turbo-jet, the Iroquois. Some of the design achievements in this power plant are amazing. If, for instance, achievements in the engine's power-to-weight field could be applied to automotive engineering, today's average automobile engine would weigh only 5½ lbs. The Iroquois team have gone all-out for simplicity too. Even including the after burner, the Iroquois is made up of fewer parts than the Orenda series of engines without after burner.

Next month in Design Engineering

OCTOBER

Non-circular gears—Results of a thorough investigation into the basic (but little-known) principles involved in the design of non-circular gears.

Frontier 40-E—An aluminum alloy specially developed to produce high strength aluminum castings not requiring the usual heat treatment to attain the desirable physical properties.

Cermets—These materials are finding wide application in fields where high temperature, wear, oxidation, corrosion, thermal shock and erosion are problems.

Evaporograph—A device that makes temperature differences visible and permits measurements from the images produced.

Temperature control—A discussion of some of the major factors that affect the design of a temperature controlled system.

Drafting efficiency—A study of the physical factors that play a part in the performance of the man at the drafting desk.

Trends

Silicone rubber
The windshield panels on the Convair B-58 aircraft are not of conventional safety glass. The interlayer is not plastic but rubber: high temperature silicone rubber, made especially for the purpose by Dow Corning Corp. Identified as Silastic Type K Interlayer, it is the first transparent rubber of any kind on the market.

Automobile design
Engineers took a broad look at future plans for motor vehicles and engines at the recent SAE Summer Meeting.

The program put emphasis on progressive improvements in design and performance, research, changing trends and European practice. Members considered new tools and processes, radioactive tracer techniques, ride and comfort measurements and types of power-plant for tomorrow's vehicles.

Cabin doors
How Convair solved the problems involved in the design of cabin doors for its 880 jet transport airplane were described at the recent San Francisco meeting of the ASME.

The result is a lightweight, plug type door which affords maximum safety and ease of operation.

Vacuum metallurgy
This new industrial technique is transforming ancient methods of working with metals and giving engineers an important new tool in their efforts to produce faster aircraft, nuclear processes (although it has some commercial applications today) has even more potential for the future, according to an ASME technical paper by Robert C. Bertossa.

Vacuum metallurgy is used in working with certain metals that ordinarily combine with gases from the air when heated. By surrounding the hot metal with a vacuum, the unwanted reactions can be eliminated. This makes it possible to manufacture products that cannot be obtained in any other way.

Molybdenum
The successful commercial extrusion of tubing made of molybdenum (a metal particularly suitable for nuclear power plants, jet engines, rockets and missiles) has been announced by Wolverine Tube.

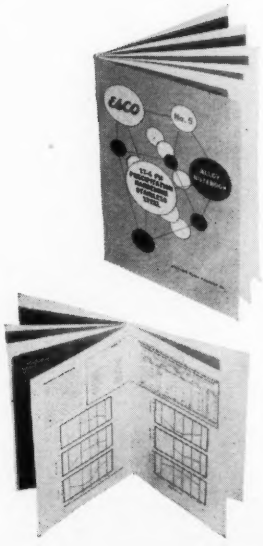
The new extrusion process was developed in co-operation with Climax Molybdenum Company, who supplied the molybdenum billets as well as the necessary basic data on the metal's characteristics. In the past, the high strength of the material at extrusion temperatures had been a barrier to commercial extrusion.

JUST OFF THE PRESS

ESCO ALLOY NOTEBOOK No. 5

PRECIPITATION HARDENING ALLOY 17-4 PH *

* Armco Licensee



Here is the first information published on the mechanical properties after various heat treatments, of cast alloy 17-4 PH. This true heat and corrosion resistant stainless steel can be machined, in its relatively soft as-cast condition, and hardened to 400 BHN at low temperatures. 17-4 PH also has the ability, through heat treating, of being adaptable to a wide range of applications requiring high strength, ductility and impact resistance.

This report of a continuing study contains pictures, tables and graphs, showing such things as the microstructure before and after annealing and the comparative mechanical properties of 17-4 PH.

Industry as diversified as aircraft parts, food processing equipment and chemical pump manufacturers are among the enthusiastic users of Alloy 17-4 PH.

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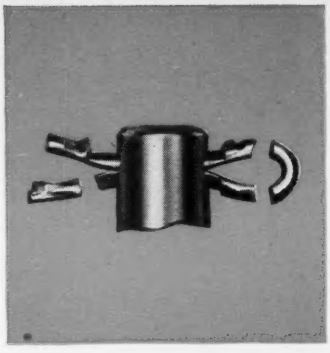
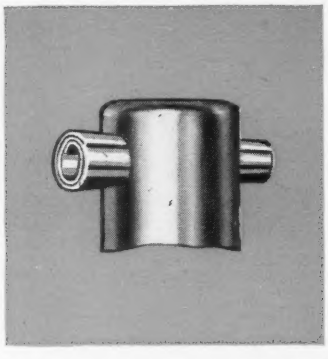
Spirol Pins in Morse Roller Chain resist vibration, absorb shock.



Standard heat-treated cotter pin fails after only 3 hours on fatigue tester. Failure in use means costly downtime.



Spirol Pin shows no sign of fatigue after 50 hours on tester. And it won't shake out or break off like cotter pins.

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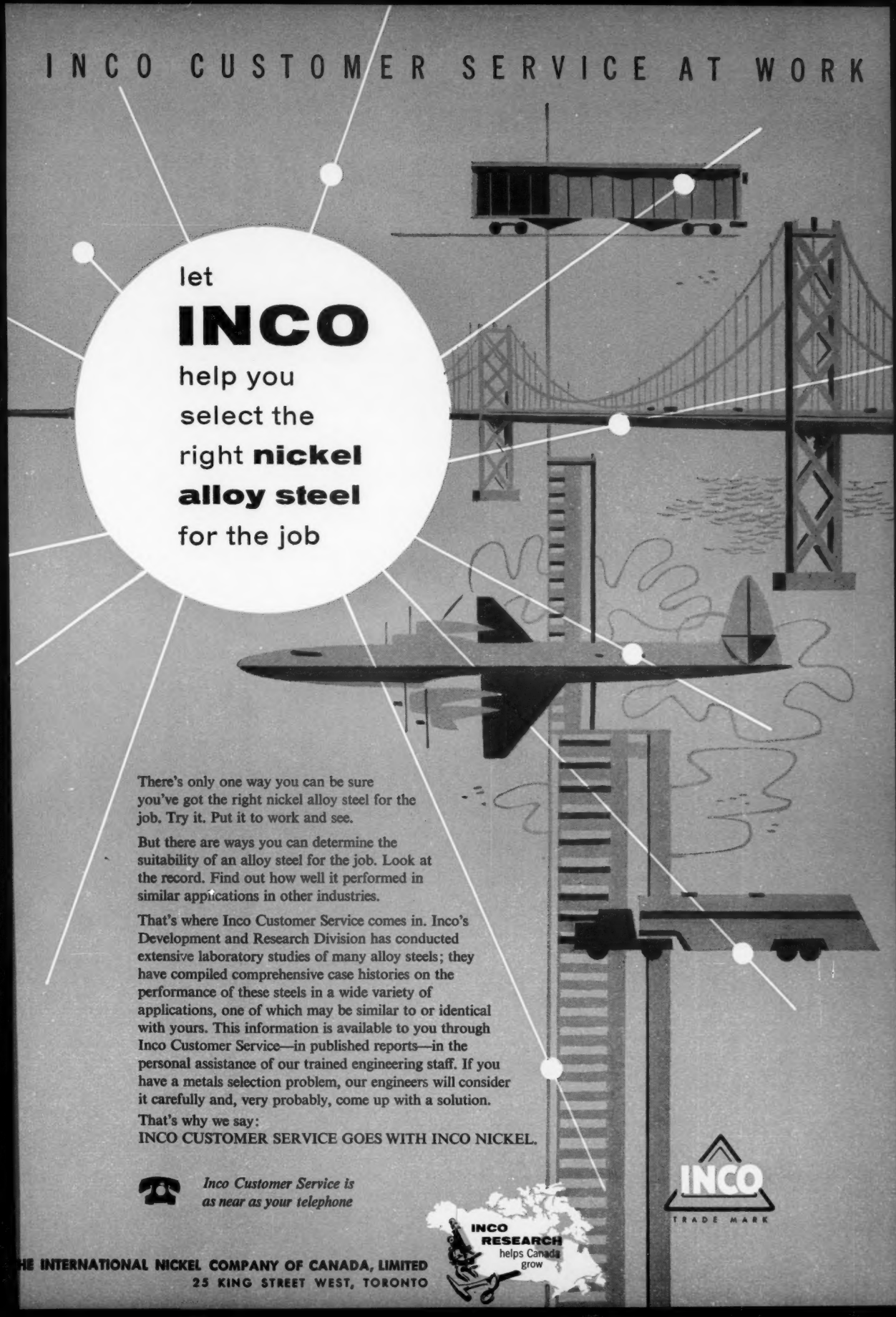

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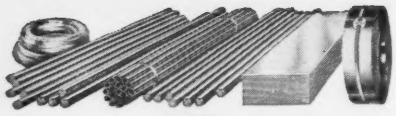

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COPPER ALLOY BULLETIN

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Export Department, P. O. Box 1238 Place D'Armes, Montreal, P. Q., Canada

Various types of bolts made from Noranda Silicon Bronze have extremely high strength.

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Copper and its alloys offer a combination of properties that make them of prime importance in the design and operation of electrical equipment. These properties include high electrical and thermal conductivity, ease of forming and fabrication, and excellent resistance to corrosion, fatigue and wear.

Electrolytic Copper

Electrolytic Tough Pitch Copper is by far the most commonly used metal for electrical purposes. It is the best conductor of electricity commercially available and can be readily stamped, formed, spun, brazed and soldered... offering extreme ease of working in either the hot or cold state.

Noranda Electrolytic Copper Bar (Alloy No. 102) is the recommended material for a wide variety of applications such as bus bar and pipe circuit breakers, stators and rotors of generators and motors, switchgear appliances, plating racks and many others including structural members subject to corrosive attack.

Tellurium Copper

Specifications often call for the use of high conductivity copper parts that must be turned out by screw machine methods. Pure copper is difficult to machine. Additions of small amounts of Tellurium, however (0.5 to 0.6%), raise pure copper's machinability rating from a poor 20 to an excellent 90 on the basis of 100 for free-cutting yellow brass.

Surprisingly, machinability is the only property that is drastically affected by this addition. Electrical and thermal conductivity remain practically unchanged as does hot workability, while cold workability is only somewhat reduced. Noranda Tellurium Copper is proving increasingly valuable in an ever-growing number of applications.

Silicon Bronze

Noranda Silicon Bronze (Alloy No. 609) is one of a number of engineering alloys developed for forming by cold extrusion processes or cold upsetting. This superior alloy, besides being extremely malleable and ductile even in the hard drawn condition, is remarkably strong, averaging over 100,000 psi in tensile strength.

Because of its excellent resistance to corrosion by weathering, it is fast replacing rustable materials in bolts, nuts, screws and fastenings of many kinds for wire and cable connectors, pole line hardware, etc.

Noranda Silicon Bronze is recommended for making bolts with exceptionally large heads. When properly made, it is not necessary to provide heat treatment of the finished cold upset items to relieve stress.

Phosphor Bronze

When it comes to vital spring parts in electrical equipment, the cost of failure is always greater than the price of a superior spring material. Whether a spring must maintain constant pressure and good electrical contact, as in a wall plug receptacle, or whether it is called upon to flex back and forth thousands of times, dependability is a prime factor.

In order to assure fine spring properties, high fatigue resistance and maximum dependability, Noranda's Phosphor Bronze is produced with the most modern casting, annealing and mill equipment in Canada. Its composition, temper and finish are checked and rechecked by rigid laboratory control to make sure it meets the requirements of modern mass production methods and high standards of performance quality.

Noranda Phosphor Bronze (Alloy No. 36) is widely used for electrical snap switches, diaphragms, current collectors, spring contacts and parts for radios and electrical instruments, to mention but a few.

Other Noranda brass alloys are used extensively for high-strength structural members where outstanding resistance to corrosive attack is required.

Make Noranda Your Source

In the growing Canadian metals market, make sure your source of supply is always dependable and always capable of meeting your most specialized requirements. Noranda offers this dependability and this versatility to its customers, backing them with Canada's most modern and completely equipped copper and brass mills.

The staff of qualified engineers of Noranda's Metallurgical Laboratory and Noranda's Technical Service will be glad to assist you with your metal problems and recommend the alloy or alloys that best meet your requirements. These services are available through your nearest Noranda Representative.

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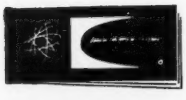
HERE'S GLIDDEN "FOLLOW-THROUGH" IN ACTION!



INFORMATION YOU'LL VALUE! This Booklet outlines all Glidden Technical and Laboratory Services—and how you can profit by them. We will gladly send you a free copy

How will a product finish behave when it's applied at the manufacturer's own plant? To find out, Glidden often tests it *right on the production line.*

Here at Ford of Canada's assembly plant, for instance, Glidden technicians work with the plant's finishing experts to check the performance of the finish in every detail. But this is only the *final* test. Behind it lies painstaking research in the Glidden Laboratory—plus detailed application tests—to develop the ideal finish.

This is typical of the Glidden policy to constantly develop and test better methods of applying all types of industrial finishes. That's why our plant is so completely equipped. And that's why we have had such success in preparing a vast variety of industrial finishes to meet widely varied conditions.

Today, more than ever, competition demands that your products have the most attractive and practical finish. Why not use Glidden services to help you achieve this objective?

QUALITY Glidden PRODUCTS

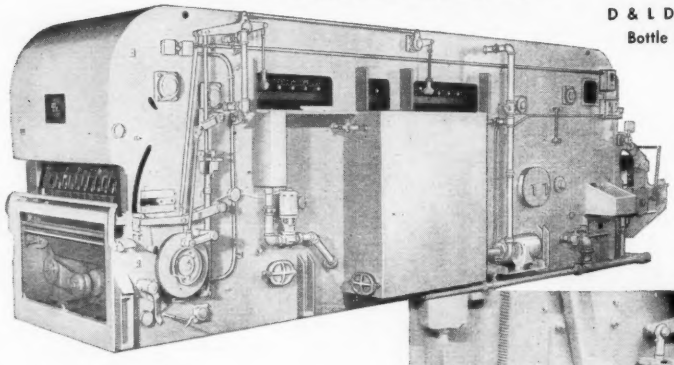
THE GLIDDEN COMPANY LIMITED • Technical Service Department, 351 Wallace Ave., Toronto 9, Ont.

Heim *Unibal* Rod Ends

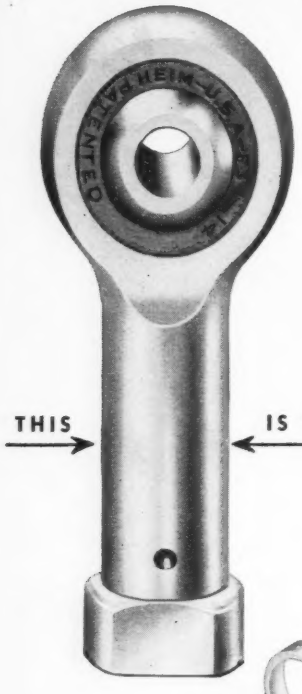
compact . . . easily adjusted . . . bind-free

The Dostal & Lowey Company manufactures automatic bottle washing machines. There is a Single End machine of rugged construction which can be operated by unskilled labor; and there is a Double End washer of great speed and efficiency for high production.

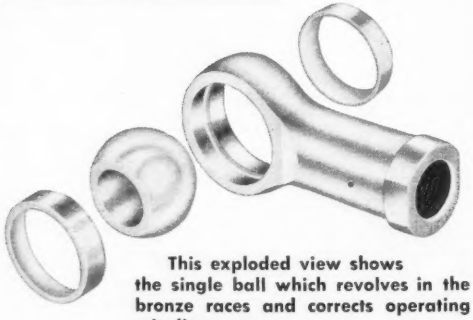
The D & L Single End machine uses 28 and the Double End machine uses 14



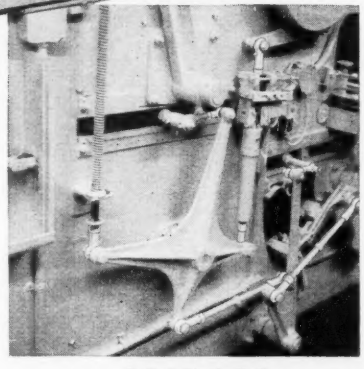
D & L Double End Bottle Washer



THIS → ← IS THE HEIM UNIBAL



This exploded view shows the single ball which revolves in the bronze races and corrects operating misalignments.



D & L Single End Bottle Washer

Have *You* considered the versatile Unibal for your linkages? Heim engineers will help you with suggestions and samples. The leading bearing distributors carry Heim Unibal.

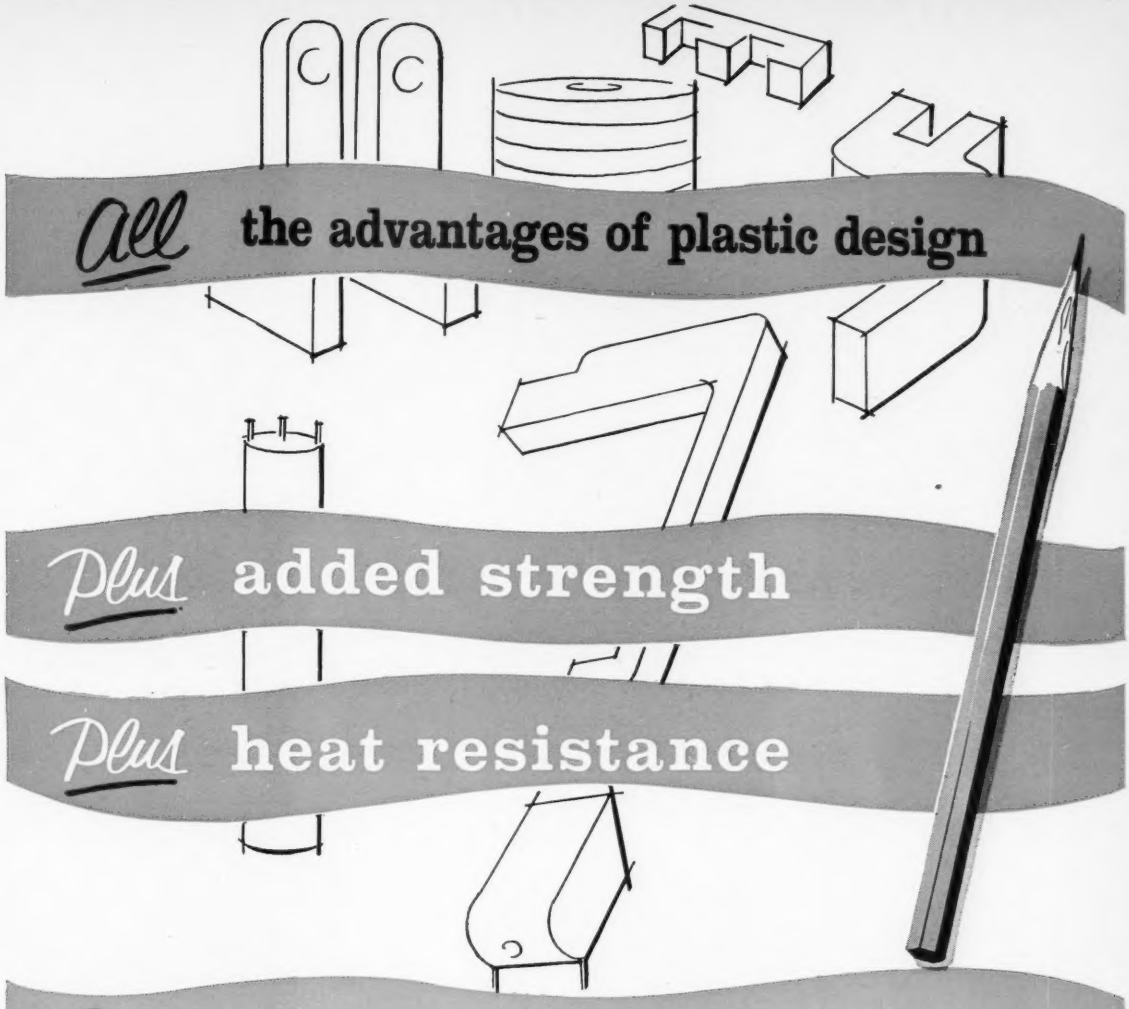
R&M BEARINGS CANADA LTD.

Unibal has many advantages, but those features which led D & L to choose Heim Rod Ends were their compactness, their ease of adjustment after installation, and the fact that they operate with a bind-free smoothness. The minimum maintenance (not a single failure or replacement in six years of use) and self-alignment of Unibal further improves the smooth operation of the D & L Bottle Washers.

The use of Heim Rod Ends in practically all motions of the machines has helped to bring out an important sales point — spare parts inventory is kept to a minimum.

QUEBEC CITY	MONTREAL	WINNIPEG	THREE RIVERS	TORONTO	VANCOUVER	LONDON, ONT.	HAMILTON
755 Blvd. des Capucins	1006 Mountain St.	1302 Notre Dame Ave.	375 St. Georges St.	338 50 Edward St.	1066 Seymour St.	1024 Oxford St. East	130 Ferguson Ave. N.

FACTORY REPRESENTATIVES AND DISTRIBUTORS FOR CANADA



All the advantages of plastic design

Plus added strength

Plus heat resistance

Equals FIBERGLAS* reinforced *plastics*

When plans are in the fluid stage . . . that's the time to consider what reinforced plastics can offer. Most plastics are out-classed when it comes to the questions of strength and heat resistance. But Fiberglas reinforced plastics are incredibly tough and show an excellent heat resistance. They have colour and lightness. You can mould them to suit the most intricate shape. They resist abrasion and withstand weathering.

*T.M. Reg'd.

IT'S AMAZING THE DIFFERENCE FIBERGLAS MAKES

FIBERGLAS*
FIBERGLAS CANADA LIMITED

FURTHERMORE
These familiar plastic items were made possible by *Fiberglas Reinforced Plastics*

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"Finished" before fabricating, pre-coated metal eliminates such costly time and space-consuming operations as cleaning, tumbling, spraying, dipping, rust-proofing, baking, drying and finishing.

Pre-coated metal withstands the stresses of drawing, bending and forming without cracking, chipping, peeling or blistering. Its smooth, lustrous finish "stays put" because it is uniformly applied in a continuous closely controlled process.

Wastage is kept to a minimum because pre-coated metal comes coil-wound in the width you specify.

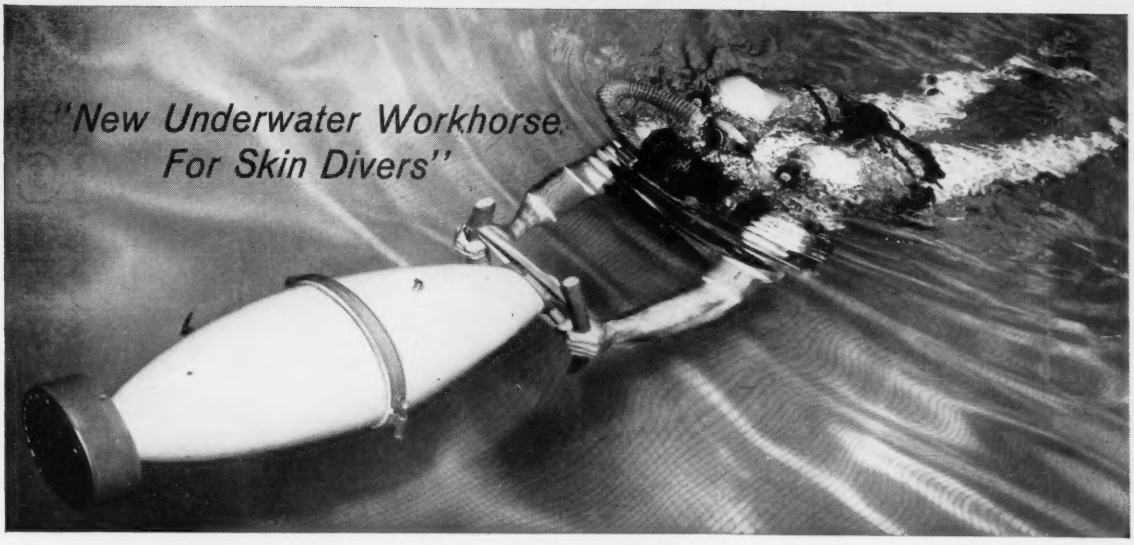
Reduces risk of fire hazard too.

Investigate the advisability of introducing pre-coated metal into your manufacturing operation.

Write . . . Phone . . . Wire

Hunter Douglas Ltd.

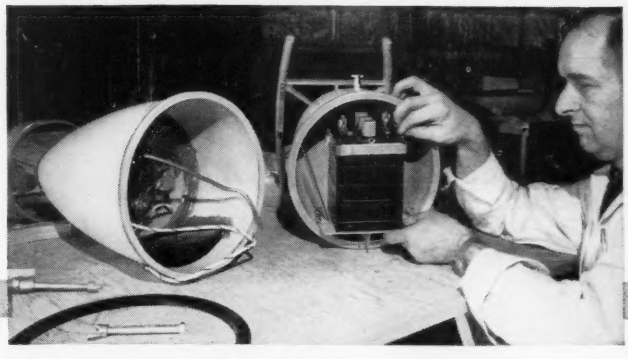
9500 St. Lawrence Blvd., Montreal **DU. 1-3981**



Constructed With Sturdy, Dependable

POLYLITE

Resin



● Top performance under tough conditions . . . that's what's required of these one man underwater propulsion units made by the Link Aeronautical Corporation of Endicott, New York.

The basic shell material for this "Power Diver" must be able to withstand the pressures of 100-foot dives . . . must be able to resist the corrosive effect of the sea . . . and must still be light enough for a man to carry the unit out of the water. These are just some of the physical requirements that must be met for such a product as this . . . and met at a price that doesn't take the product out of the sportsman's reach!

"That's why we chose a combination of RCI POLYLITE and fibrous glass," states Felix Aimonetti, vice president and general manager of Link. "From the standpoint of design, engineering and cost, reinforced POLYLITE was the perfect solution for our shell material.

"Besides all this, the capital outlay we needed for this type of construction was relatively low, and we found that even without the benefit of prior manufacturing know-how during the first weeks of production, we were able to turn out a consistently uniform product. All things considered, the use of RCI POLYLITE reinforced with fibrous glass has cut our production costs at least 75%."

Products possessing the unique advantages of RCI POLYLITE — lightweight strength, durability, and easy maintenance — are becoming increasingly popular and profitable in today's market. Perhaps POLYLITE polyester resin can be incorporated into one of your products. For additional information about what you can do with RCI POLYLITE in laminating, molding or other plastics applications, write for free *Booklet A*.

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Here's where you'll find the RIGHT PLASTIC backed by the RIGHT SERVICE

FROM DOW—A family of plastics to meet specific needs.

***STYRON**

STYRON 666 — a widely used general purpose formulation of high purity with physical properties that include good aging characteristics, clarity and surface hardness.

STYRON 688 — features good moldability with controlled flow and pressure distribution in mold cavity. Exceptional balance of properties.

STYRON 689 — excellent moldability and brilliant sparkle make this formulation ideal for crystal parts. Designed especially for injection molding, having very high flow rate.

STYRON 475 — possesses exceptional uniformity, high impact strength and high elongation. It has 3 to 5 times greater impact strength, 10 times greater elongation than general-purpose polystyrene.

STYRON 440 — developed for applications such as radio cabinets where high impact and heat resistance are required.

STYRON 700 — very high heat resistance and notable gloss.

STYRON 480 — super high-impact formulation with excellent heat resistance. Ideal for uses such as lawn mower wheels, pump impellers and fittings for pipes.

***TYRIL**

A new name in plastics based on styrene and acrylonitrile. Tyril offers unequalled characteristics and balance of properties: high tensile strength, superior toughness, crystal clarity, good heat resistance, outstanding moldability, high chemical resistance and excellent aging characteristics. It's a natural for use in refrigerators, tumblers, houseware goods and numerous other products.

***ETHOCEL**

One of the first plastics, combining light weight and exceptional toughness. Resists many chemicals over a wide range of temperatures. One of its formulations is self lubricating for such applications as roller wheels and oil-less gears.

* Trade marks of Dow Chemical of Canada, Limited

Most often, getting the right plastic for a specific use depends on two things: (1) a broad range of plastics from which to select the exact properties needed and (2) adequate back-up service from the manufacturer. From Dow you get both!

A pioneer in thermoplastics development and production, Dow, today, is the leader in this field. And as such, Dow maintains extensive laboratories in Sarnia where the toughest problems meet research scientists, technicians and engineers. Many of these experts have grown with the industry from its beginning. Their experience — plus the talents of production, styling, colour and marketing service — combine to give you unequalled support in selecting, fabricating, forming and selling plastic products.

Papers, technical bulletins and brochures covering every detail of plastics applications, methods and equipment have been written and kept up to date. This literature as well as personal attention is yours for the asking. Contact our nearest sales office, or write direct to: DOW CHEMICAL OF CANADA, LIMITED, 600 University Avenue, Toronto 2, Ontario.

DOW CHEMICALS

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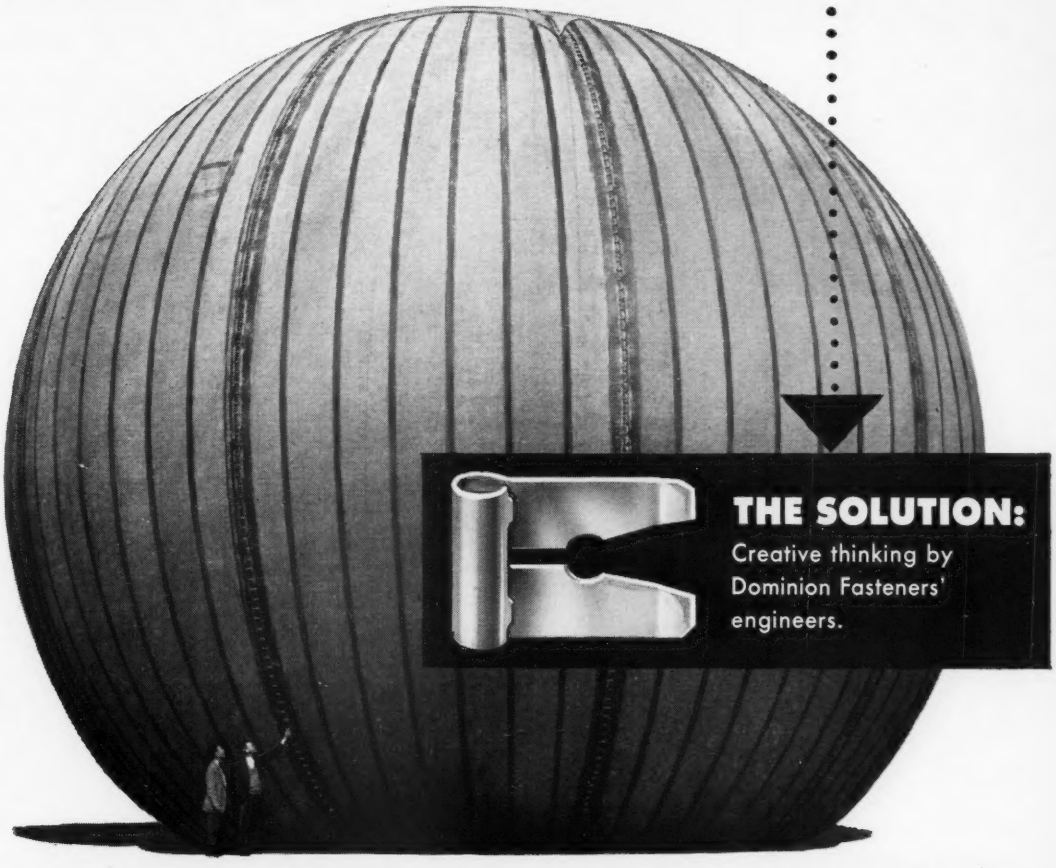
THE PROBLEM:

To create and manufacture a practical fastening device to close the seams of the world's largest* Radome . . . to make it simple enough to do the job quickly and easily in sub zero temperature while wearing heavy Arctic-type mitts.



THE SOLUTION:

Creative thinking by Dominion Fasteners' engineers.

Solving tough problems is routine at the Hamilton plant of Dominion Fasteners Ltd. Through a combination of modern facilities and creative personnel, this Canadian company is continually inventing, developing and producing better fastening methods for a wide variety of industries.

Whether you make Radomes or radiators, Dominion Fasteners Ltd. are always ready and able with an efficient, economical solution to your fastening problems.

*The world's largest air-supported Radome was recently completed by Firestone Tire & Rubber Co. of Canada Ltd. Constructed for the USAF by the Electronics Division of Westinghouse under a contract from ARDC's Rome Air Development Center, the Radome measures 61 feet in diameter and is designed to protect radar antennae equipment from extreme weather conditions at remote defense installations.

The flat-type Speed Nut from which has grown a family of over 6000 types and sizes of spring tension fasteners.

DOMINION FASTENERS LIMITED

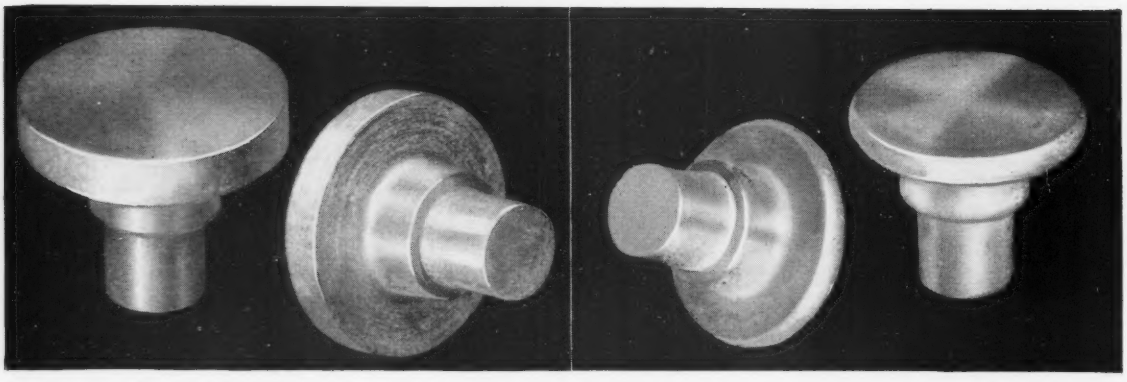
Canadian Licensee and Manufacturer of HAMILTON, ONTARIO

TINNERMAN Speed Nuts TRADE MARK a Geo. A. Tinnerman corporation

TO SAVE ON FASTENERS

Standardize your Specials

THROUGH STELCO COLD HEADING



Machined "Special" . . . slightly redesigned as a Cold Headed "Standard"

The simple Flat Head Shoulder Rivet shown on the left above (enlarged), was slightly amended as seen on the right, to permit production by cold heading instead of by machining. The elimination of scrap loss, combined with increased speed of production, brought a saving of 80% to the purchaser.

Pictured below are several other "specials" standardized by Stelco with considerable cost reduction.

57121.B

Result - 80% Savings!

Stelco's modern bolt-making facilities, plus the services of Specialty Fastener Representatives, offer you three ways to save on "special" fasteners —

FIRST — Many types of contoured parts can be produced by cold heading more economically than by machining. Not all savings are as impressive as the one illustrated above, but *cost reductions in the region of 40% are not uncommon* and are often accompanied by minor redesigning which adds to the strength of the part. Secondary operations, such as thread rolling or cutting, knurling, extruding, flattening, piercing, drilling, broaching, and bending are also provided for in Stelco's facilities.

SECOND — Stelco will carry as stock items your long-run repetitive "specials" — giving you a ready source of supply and the benefit of large-quantity prices.

THIRD — Your "special" requirement might already be in stock as a Stelco "Standard" — or possibly an existing "special" could meet your needs. In either case you would realise a saving.

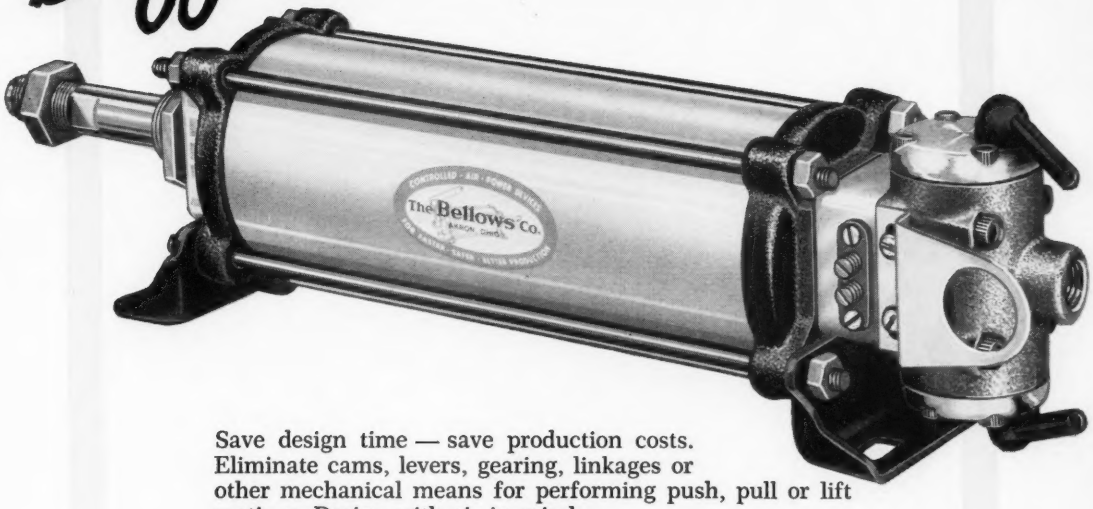
Why not ask Stelco's Engineers to examine *your* "specials"? If they are adaptable to production by the cold heading process your cost reductions will be substantial. Any Stelco Sales Office is at your service.

THE STEEL COMPANY OF CANADA, LIMITED

Executive Offices: Hamilton and Montreal

Sales Offices: Halifax, Saint John, Montreal, Ottawa, Toronto, Hamilton, London, Windsor, Winnipeg, Edmonton, Vancouver. J. C. Pratt & Co. Limited, St. John's, Newfoundland.

SIMPLIFY MACHINE DESIGN WITH THIS *Different* AIR CYLINDER



Save design time — save production costs. Eliminate cams, levers, gearing, linkages or other mechanical means for performing push, pull or lift motions. Design with air in mind.

The Bellows Air Motor is a complete electrically-controlled air cylinder power unit with directional valve and speed controls built in. It requires only one air connection which can be made with flexible hose. Compact, space saving, it fits well into crowded quarters or on moving machine elements. It is fast, responds to a starting impulse instantly. It is easily interlocked and synchronized with related machine movements. Its quality and reliability has been proven in more than quarter of a million installations.

The range of work it can do is limited only by the imagination of the design engineer.

Send for this free booklet

Here in these quick reading pages is the full story of The Bellows Air Motor — what it is doing for others, what it can do for you. Address Dept. DE957 The Bellows Co., Akron 9, Ohio. Ask for Bulletin BM-25. In Canada, write Bellows Pneumatic Devices of Canada, Ltd., Toronto, Ontario.

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PNEUMATIC DEVICES OF CANADA, LTD.
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modernize and economize with these two new

Bendix COMPLEMENTARY CONTROLS

Continuous and Automatic

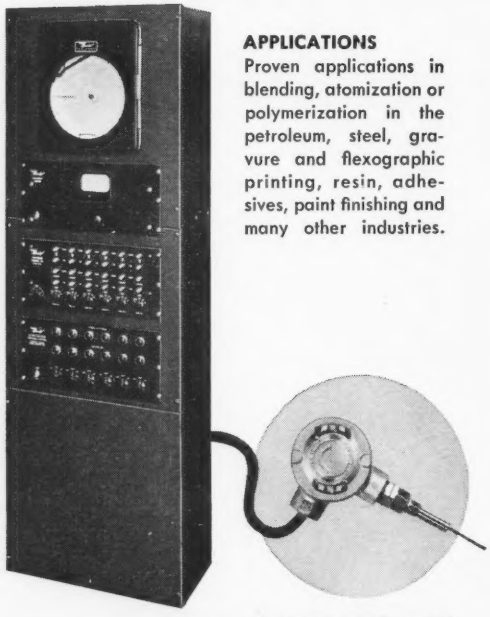
NUCLEAR DENSITY GAGE

Sensing element not in contact with process fluid; ideal for corrosive, abrasive and viscous liquid systems.

APPLICATIONS

- Density
- Specific Gravity
- Liquid Concentration
- Per Cent Solids
- Vapor/Liquid Ratio
- Liquid Level
- Interface Detection

MULTIPOINT ULTRA-VISCOSON ELECTRONIC VISCOMETER



APPLICATIONS

Proven applications in blending, atomization or polymerization in the petroleum, steel, gravure and flexographic printing, resin, adhesives, paint finishing and many other industries.

Probes hermetically sealed —no moving parts.

CABINET SPECIFICATIONS

Standard rack panel mounting; dust-proof; air purgable (air purge kit available from Bendix).

Features:

The Bendix Nuclear Density Gage is designed for process pipelines. Range, Span and Time Constant adjustments on front panel. Meets every AEC requirement for industrial use. Range: 0.3 to 3.5 Sp. Gr. range with a minimum span of 0.05 Sp. Gr.

The Bendix Multipoint Ultra-Viscoson* electronic viscometer controls one to six individual stations. Automatic or manual selection of probe stations. Automatic or manual control of valves. Installation in pipelines, kettles, reactors. Ranges: 0—50,000 centipoises x grams/cc.

*REG. U.S. PAT. OFF.

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You can get the *custom designs* you want from a basic Skinner Solenoid Valve

In the small-size solenoid valve field, Skinner offers a wider variety of variations and optional features than any other manufacturer. Take, for example, the standard V5 model shown above in cutaway form. Its design is so flexible that the valve can be supplied for applications which would otherwise call for "specials." So, if you have a solenoid valve problem, we urge you to talk to a Skinner representative. Tell him your requirements in regard to port sizes and locations, voltages, pressures, temperature conditions, flow adjustments and mountings. Let him show you how easily he can select the valve you need.

When you specify Skinner, you get custom design plus outstanding service performance. Continuous testing in our labs and actual results in the field prove that Skinner valves have exceptional leakproof life. For complete information on Skinner's line of 2-, 3- and 4-way valves, write us or contact a Skinner representative. Write Dept. 359.

Skinner Solenoid Valves are distributed nationally

SKINNER ELECTRIC VALVES

SKINNER ELECTRIC VALVE DIVISION

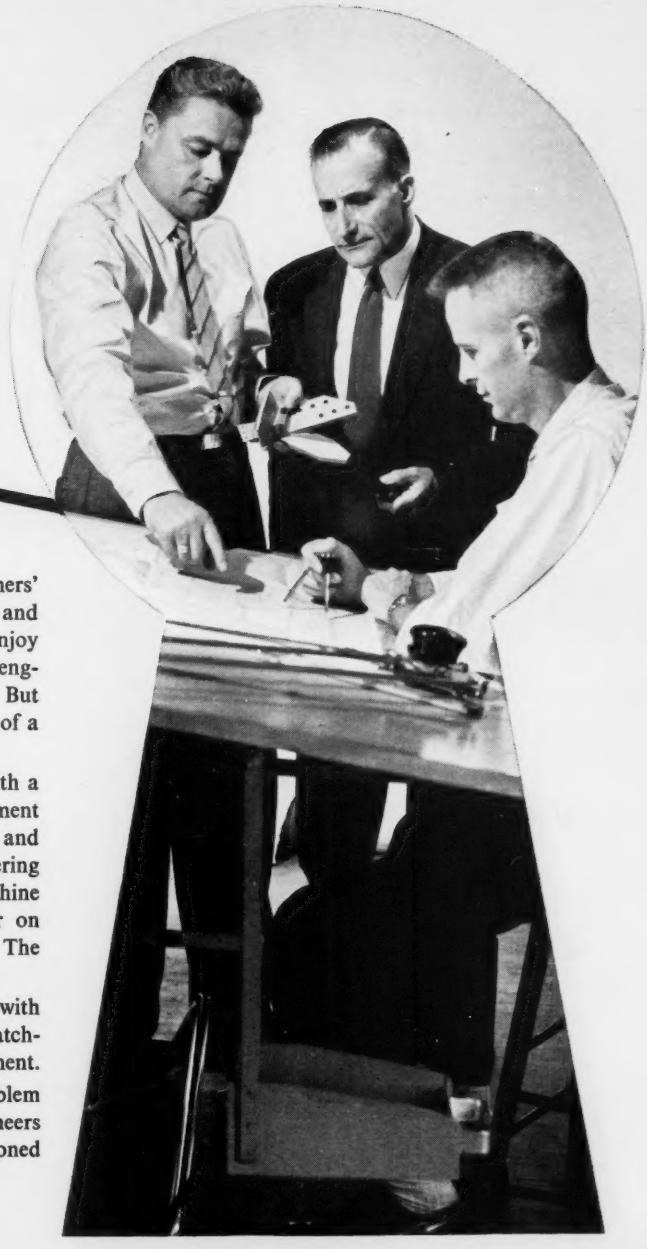
NEW BRITAIN CONNECTICUT

105 EDGEWOOD AVENUE

THE CREST OF QUALITY

problem:

our engineers' egos!

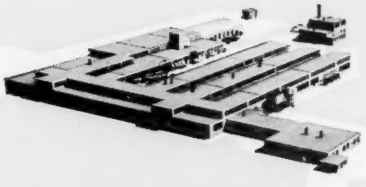


They've been solving our customers' problems much too quickly and easily of late. Of course, they enjoy complete facilities for precision engineering and for prototyping. But their successes are putting a bit of a strain on their hatbands.

So we're looking for a client with a "poser"... a good taxing assignment in design studies... or in design and development work... engineering design work on aircraft or machine components and assemblies, or on fuel and oil-handling equipment. The tougher the better.

Technical excellence combined with maximum productibility is the watchword of our Engineering Department.

Would you have such a problem handy? It would serve our engineers right by keeping their talents honed and their egos under control.



Renfrew

AIRCRAFT & ENGINEERING COMPANY LIMITED

Contracts Dept., 660 St. Catherine St. West, Montreal
Plant: Renfrew, Ontario.

RA57-3T

The designer: "Lends itself more readily to modern, functional styling."
The sales manager: "Satincoat leads to easier sales. Customers know steel stands up over the years."
The cost accountant: "Cuts manufacturing costs without sacrificing quality or lasting beauty."
The production manager: "Steps up production by eliminating need for dipping after fabrication, or priming before painting."

The experts agree on

DOFASCO satincoat

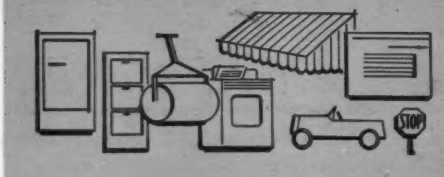
for versatile low-cost fabrication...

Satincoat is a new, zinc-coated steel that provides every advantage of imported electro-galvanized steel but at far less cost! Manufactured in Canada by the continuous galvanizing process, *satincoat's* protective zinc coat remains uniform during fabrication. Will not crack or peel to expose base metal. Takes paints, lacquers or enamels without costly priming or risk of underfilm corrosion.

For more information on the cost-cutting properties of *satincoat* . . . and the contribution it can make to the good name of your products . . . *see your steel distributor*, or write to

DOMINION FOUNDRIES AND STEEL, LIMITED
HAMILTON ONTARIO CANADA

For better products at lower cost...



satincoat by Dofasco

23-5251

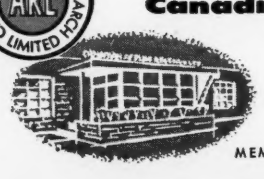
Preparing to test a Company produced rocket-firing intervalometer at −65° F. at 60,000 feet aititude

A commercial environmental test lab in Canada!

One of Canada's first privately owned and commercially available environmental test laboratories is ready now—at your service. It is designed to test components and systems to military and commercial specifications. Here are two of the many test chambers. The left chamber tests at temperatures from −35° F. to 300° F., and at humidities from 20% to 98%. The right chamber provides temperatures from −100° F. to 300° F., at altitudes from sea level to 100,000 feet. If you have a qualification testing problem write for information on this new service to Canadian industry. Quotations are available on request.

Qualification testing for your products and research problems to current MIL Specs.:

- low temperature
- high temperature
- altitude
- humidity
- shock
- vibration
- salt spray
- sand and dust
- radio interference
- explosion
- fungus
- wind tunnel



Canadian Applied Research Limited

(formerly PSC Applied Research Limited)

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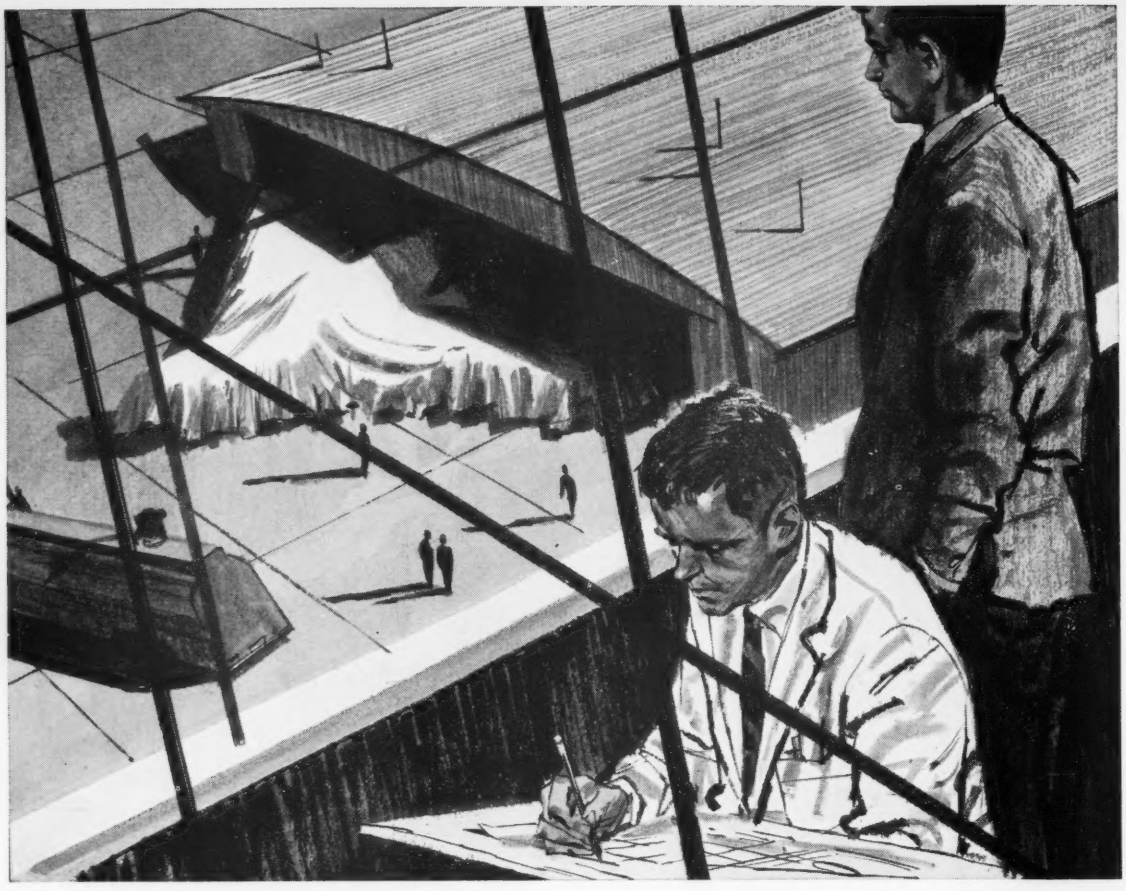
MEMBER: A. V. ROE CANADA LIMITED & HAWKER SIDDELEY GROUP



Avro Aircraft Limited has achieved a brilliant record, creating the famed Jetliner, the rocket-firing CF-100 and soon now, the supersonic Avro Arrow. Still shrouded in secrecy, advanced aeronautical projects now in the design stage, present new challenges to men with imagination and vision who have a sound background in engineering, mathematics, physics, aerodynamics, metallurgy or computer programming.

startling things are happening in CANADA at AVRO

Enthusiasm and excitement keynote all aspects of design and engineering at Avro. For Avro Aircraft's advanced projects are pushing into the thermal thicket . . . rising into the stratosphere. There new mysteries remain to be solved; new challenges loom for men with skill and ingenuity.

Association with these projects stimulates the creative imagination of the engineer, the mathematician, the metallurgist and aerodynamicist. Every problem becomes a new, interesting and inspiring experience.

You will work in Malton, Ontario, a suburb of Metropolitan Toronto. You will be assigned to an advanced engineering team. You will be assisted by the most advanced electronic computing equipment in the world. You will receive company-paid group life, sickness and accident insurance and you will be eligible to participate in a retirement income plan. Your progress will continue as rapidly as you demonstrate your ability.

For complete information, write us today. We will forward application forms and gladly answer any questions you may have.

AVRO AIRCRAFT

EMPLOYMENT MANAGER

AVRO AIRCRAFT LIMITED

BOX 4004, TERMINAL "A", TORONTO • ONTARIO

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What is a "Good" Casting?

"Good" is the measure of performance. A good casting measures up—in performance—to all the requirements of its buyer and its end user.

If, during its life, it must withstand repeated thermal shocks, then it must be heat resistant; if it is going to be subjected to constant friction, then it must be wear resistant; if it comes into contact with salts or acids, then it must be corrosion resistant.

"Very true," you say, "and also very obvious. It is one thing to make fine castings to fit the job but can you make the price fit the castings? That's a requirement, too."

We can. That's where our Special Products Plant comes in. It is run by experienced men, controlled by a first class laboratory and equipped with modern foundry equipment —it's an operation that's geared to meet quality *and* price requirements.

Our electric furnace, for example, allows flexibility, versatility and far greater uniformity of composition in the production of all types of iron.

The result: the best possible assurance against being let down half way through the machining operation. Your shop investment is thus protected.

So when *you* need "good" alloy castings, delivered clean and on time, order them from:

Canada Iron
foundries, limited

FOUNDRY & MACHINE DIVISION

HEAD OFFICE: 921 Sun Life Bldg., Montreal — TORONTO OFFICE: 169 Eastern Ave., Toronto

Literature is available on the following engineering irons and alloy irons produced by our Special Products Plant:

If you would like valuable information on any or all of these irons, tick them off and mail this coupon.

NODULOY ☐ NI-RESIST ☐
NI-HARD ☐
DUCTILE NI-RESIST ☐

Your Name _____

Address _____

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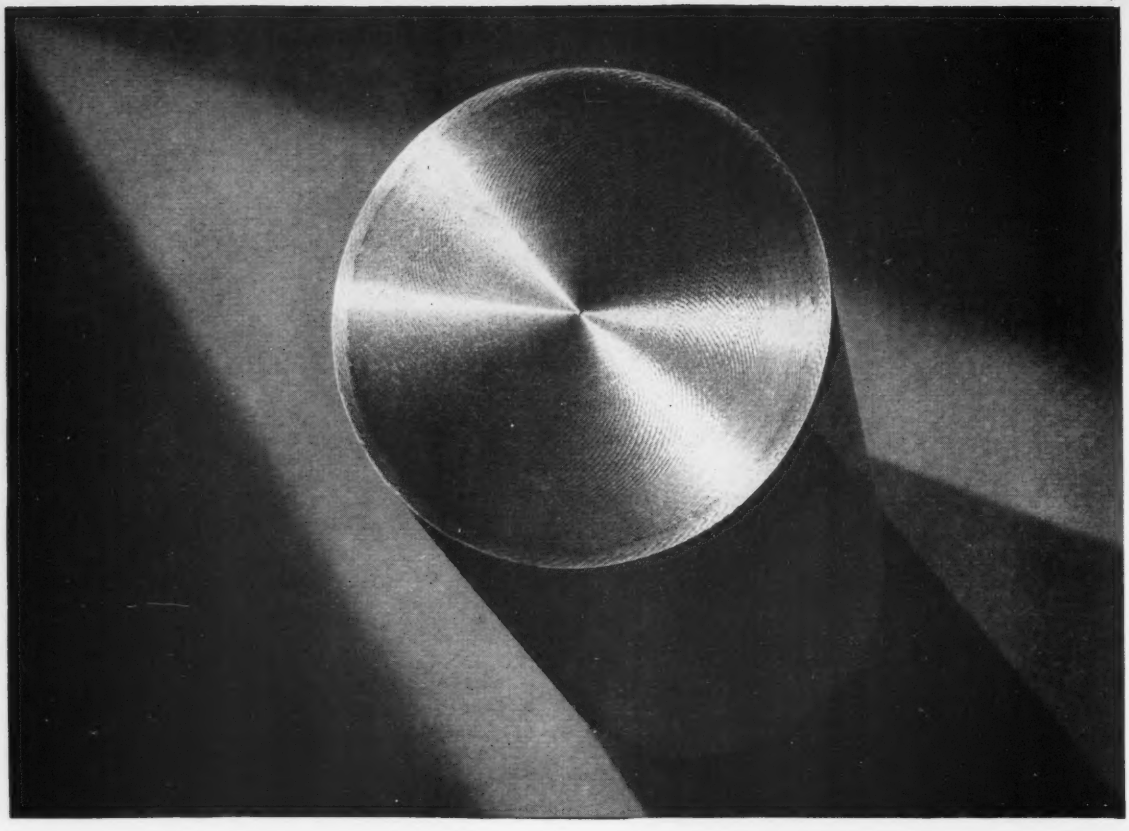

READY

This bar of metal is a metallurgical achievement. Step by step from raw ore to finished metal — special properties have been imparted to it — hidden beneath its bright surface.

Resistance to corrosion has been built into it through and through.

A generation of research has gone into it. Years and years of development have brought it to this critical point.

Now, it's ready for you! Ready in our stock — exact in physical dimensions — correct in metallurgical properties — cut to the length you specify.

The whole purpose of its creation and the whole investment in time and money that have gone into its making are primed, waiting to serve your needs.

Stainless steels . . . aluminum . . . in any one of many alloys . . . in any one of many sizes and shapes are stocked in our warehouses. Simply give us a call — we have the metal you want, ready and waiting to serve you.

ALLOY METAL SALES LIMITED

Distributors of
STAINLESS ALLOYS AND ALUMINUM IN ALL COMMERCIAL MILL FORMS

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92 MONTÉE DE LIESSE, VILLE ST. LAURENT, MONTRÉAL, P.Q.
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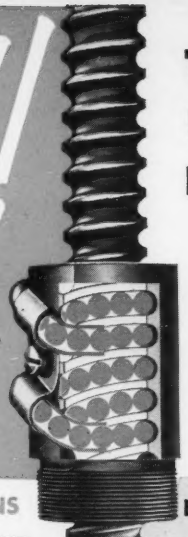
THERE IS NO PLACE FOR CORROSION IN YOUR BUSINESS

NOW!

WHETHER YOU WANT TO MOVE 2 POUNDS 2 INCHES, OR 10 TONS 10 FEET—FORGET ACME SCREWS, HYDRAULICS, PNEUMATICS, CABLES AND PULLEYS



THE HIGH-PERFORMANCE LOW-COST ACTUATOR FOR VOLUME PRODUCTS

You can Actuate it Smoother, Simpler, Surer, Speedier and Usually Cheaper with the World's Most Efficient Roto-Linear Device

TYPICAL APPLICATIONS

- Automatic Garage Doors
- Automobile Seat Adjusters and Window Lifts
- Barber and Beauty Chairs
- Bumper Jacks
- Circuit Breakers
- Convertible Top Lifts
- Die Table Positioners
- Drill Presses
- Hospital Beds
- Lifters and Lift Trucks (Lift Tables)
- Marine Steering Gears
- Welding Machines

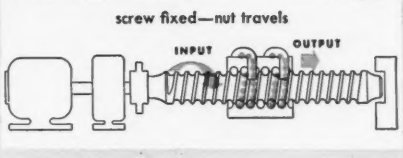
7 STANDARD SIZES

Ball Circle Diameter	Ball Size	Lead	Attaching "V" Thread Size
.375	.0625	.125	.664-32
.631 (R & L)	.125	.200	15/32"-16
1.000	.15625	.250	1.563-18
1.171	.28125	.41304	1.967-18
1.500	.34375	.47368	2.548-18
2.250	.375	.500	3.137-12
3.000	.500	.660	4.325-12

FREE ENGINEERING HELP

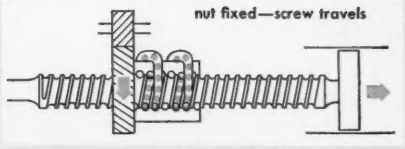
If you are currently using some other method of actuation—or think that the b/b Screw could improve the performance and sales appeal of your product, but are not sure how to apply it—let's get our heads together. Experienced Saginaw engineers, who have solved thousands of actuation problems, are at your service without obligation. Just write or phone us your requirements—or fill in and mail the handy coupon below.

BETTER ACTUATION with LOW POWER, LOW COST!



FORWARD: When rotary motion is applied to the screw, the b/b nut is driven along the axis of the screw, changing rotary motion to linear motion with over 90% efficiency.

FORWARD: When rotary motion is applied to the b/b nut, the screw is driven along its longitudinal axis, changing rotary motion to linear motion with over 90% efficiency.



GIVE YOUR PRODUCT THESE PROFIT-BUILDING PRODUCTION AND SALES ADVANTAGES:

1. With friction almost eliminated, the b/b Screw has a guaranteed minimum efficiency of 90%—performs up to 6 times better than acme screws.
2. Because of its far greater efficiency, the b/b Screw requires far less torque—saves up to 85% on operating power or manual effort.
3. The b/b Screw is smaller and lighter than comparable units; permits smaller motors and gear boxes; often eliminates clumsy auxiliary parts.
4. Smooth, almost frictionless operation assures long, troublefree b/b Screw life . . . even in extreme temperatures and with lack of lube!

Saginaw b b Screw

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Saginaw Steering Gear Division
General Motors Corporation
b/b Screw and Spline Operation
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Please send new engineering data book on Saginaw b/b Screws and Splines to:

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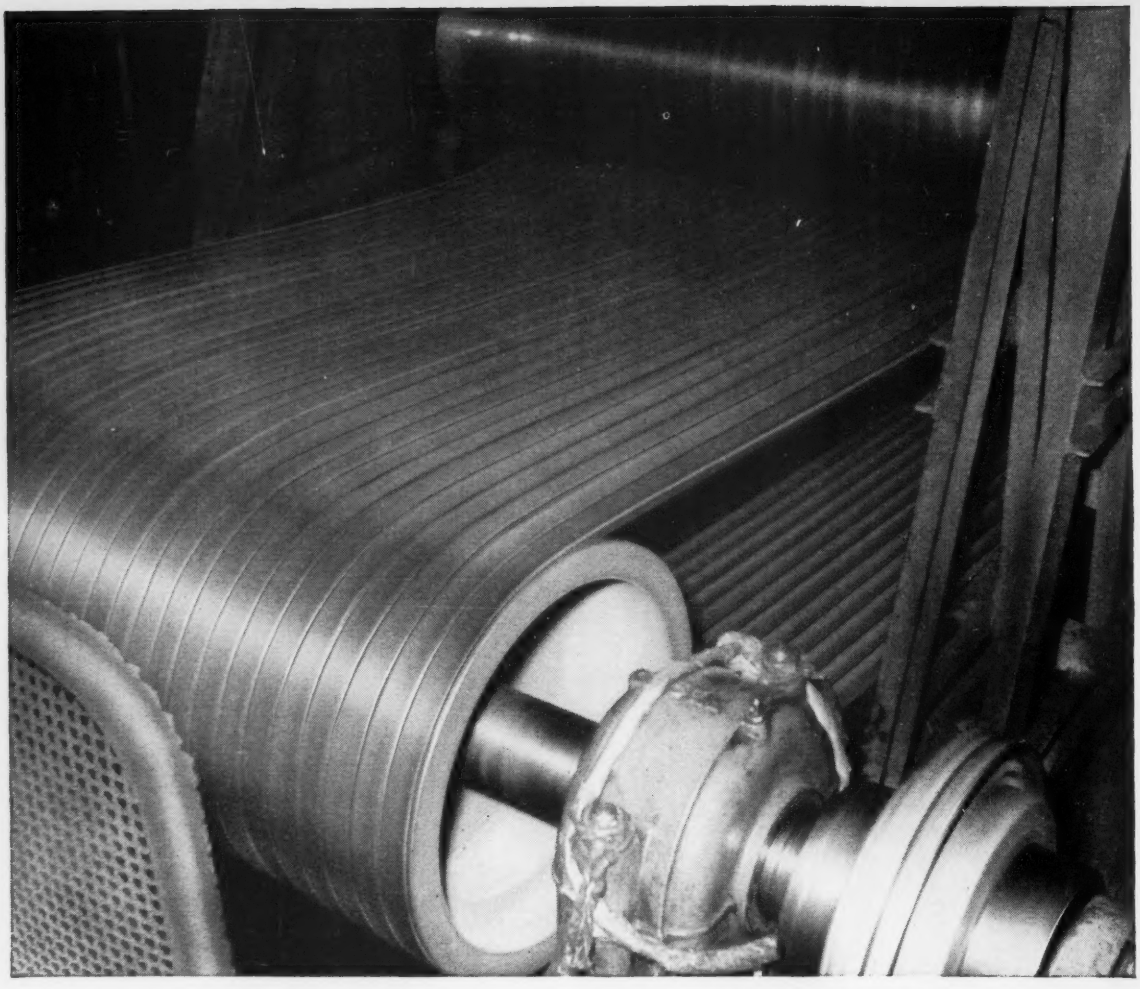
SAGINAW STEERING GEAR DIVISION OF GENERAL MOTORS • SAGINAW, MICHIGAN

WORLD'S LARGEST PRODUCER OF BALL BEARING SCREWS AND SPLINES



800 horsepower—*with a V-belt drive*

HERE'S an example of how power transmission equipment from United Steel puts horsepower to work for industry.

This V-belt drive at an Ontario paper mill has fixed centres and is equipped with a take-up idler. Thirty high capacity V-belts transmit power from an 800 h.p. motor to drive the lineshaft on one of the company's big paper-making machines.

Off-the-shelf-delivery—In addition to engineered drives like this, United Steel carries large stocks of standard power transmission equipment—some of which is illustrated below—to make off-the-shelf-delivery service possible. If you're going to pick it up, it's ready when your truck arrives—otherwise, it's on the way to you in quick time.

There's a United Steel warehouse located to serve you—just call: TORONTO, RO. 2-8242; MONTREAL, WE. 4277; KIRKLAND LAKE, 1017; SUDBURY, OS. 4-3053. *Dodge Manufacturing Division, United Steel Corporation Limited, 58 Pelham Avenue, Toronto 9.*

57-60

United Steel
CORPORATION LIMITED
TORONTO • MONTREAL • LONDON • GALT
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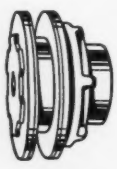
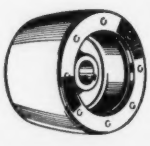
Taper Lock Sprockets



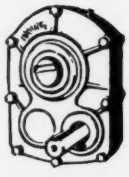
Torque Limiters

Roller and Silent Chain and Sprockets

Roller Chain Couplings



Paper Pulleys and Cast Iron Pulleys



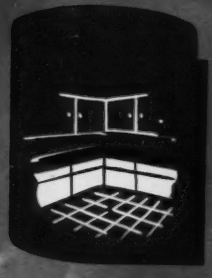
Torque Arm Speed Reducers

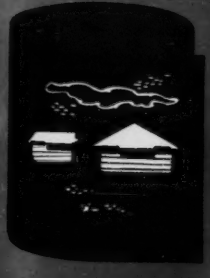
Cam Clutches

all the
advantages of
ALUMINUM SHEET
plus color too!
new low cost ALCAN

"COLORCOIL"

MAKES COLOR
ANODIZED ALUMINUM SHEET
FOR THE **FIRST TIME**
THE PRACTICAL SELECTION
FOR COUNTLESS APPLICATIONS





Have you wished for color anodized aluminum to improve your product, but found it too costly? If so, you're in for a pleasant surprise! Now Alcan "COLORCOIL" brings color anodized aluminum within the price range of a whole new world of products!

"COLORCOIL" costs less... offers more!

"COLORCOIL" is the first and only aluminum sheet with one side anodized and what's more it costs far less than conventional anodizing.

And look at these other bonuses:

The quality of anodizing is better! Better formability! Greater uniformity of color! Superior scratch resistance and your choice of six fade resistant colors for *exterior* use. It's available plain or embossed in rolls up to 48" wide, in gauges from 0.020" to 0.064" and in alloys suitable for a variety of applications.

For complete information and samples, ask any Alcan Sales Office, or use this handy coupon...

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Please send me your informative "COLORCOIL" brochure and samples of your new continuously anodized aluminum sheet.

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Company _____

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The 36 municipal parking lots operated by the Parking Authority of Toronto are easily identified by this colourful sign. Manufactured by Slimlite Signs, this sign is another example of Plexiglas at work.

Sign buyers everywhere consider signs in terms of durability, weathering, fade free colouring, and self lighting — signs made from Plexiglas get top billing on all these features. When your requirements call for outdoor signs . . . look to Plexiglas. For further information on Plexiglas for signs write to:

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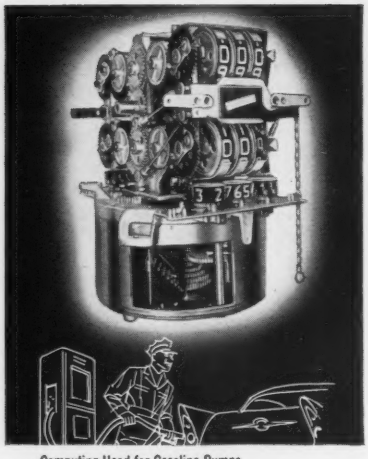
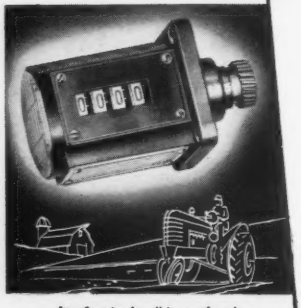


Computing Head for Gasoline Pumps

"Master Meter Duplicator" prints receipts for fuel oil delivered from trucks

"Vary-Tally" Multi-Unit Reset Manual Counter



Rev-Counter for all types of engines

Everyone Can Count on VEEDER-ROOT

Everywhere you look in everyday life, you see a familiar face . . . the face of a Veeder-Root Counter or Computer. From gasoline pumps to fuel oil trucks to textile mills . . . in the home, on the farm, in business and commerce, in modern automated industry . . . Veeder-Root standard and special devices are keeping everything under *Count*rol . . . manually, mechanically, electrically. And the mathematical probabilities are mighty high that *you* can count on Veeder-Root, too . . . to your advantage and profit. Why not let us figure out how, *right now!*

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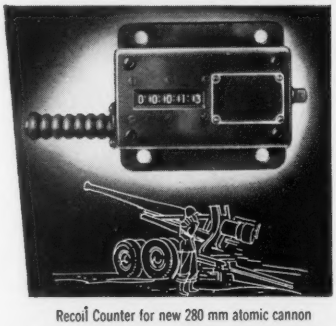
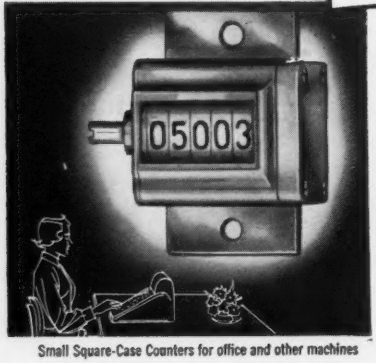


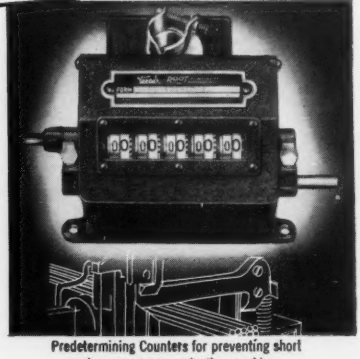
Recoil Counter for new 280 mm atomic cannon

2-3-4 Convertible Counters (and others) for textile machinery

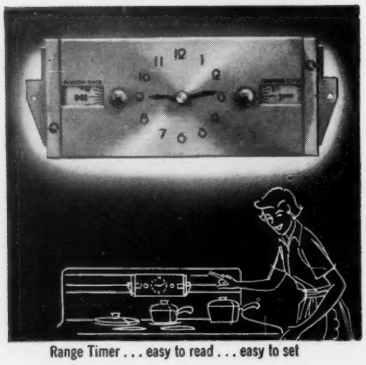
Fuel-Remaining Counter for aircraft . . . subtracts as fuel is used



Small Square-Case Counters for office and other machines



Predetermining Counters for preventing short and over-runs on production machines



Range Timer . . . easy to read . . . easy to set

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- Strong and durable in thin sections.
- Light weight (one-half the weight of aluminum).
- Easily formed, punched, corrugated and cold embossed.
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- Has low thermal conductivity and good dielectric strength.
- Available in sheet, rod and tube forms.

The virtues of National Vulcanized Fibre—a cellulosic plastic—don't end here. They may give you the answer to your current design problem.

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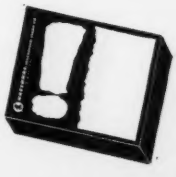
Write today for technical data and a personal set of samples of this unique material. A brief note on your letterhead will bring them without delay. Address Dept. N-9.

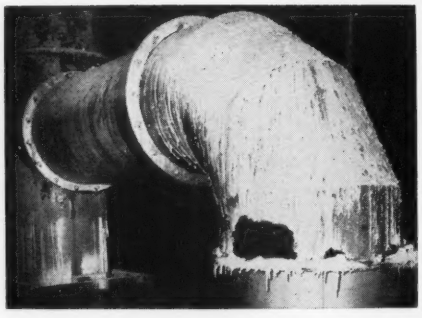


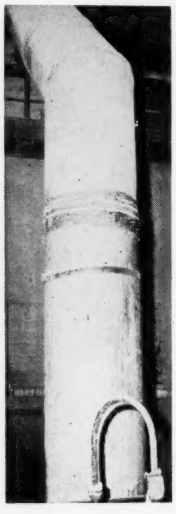
CYANAMID

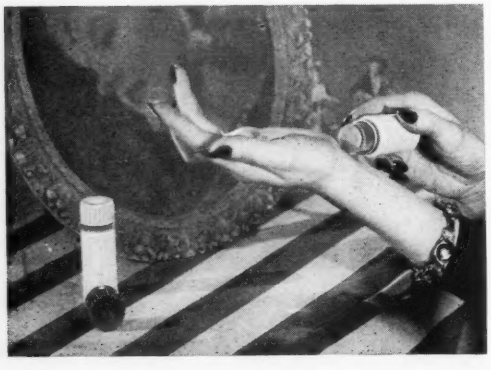
PLASTICS NEWSFRONT

THREE YEARS IN CORROSIVE SERVICE WITHOUT MAINTENANCE

That's the record established by reinforced LAMINAC® polyester resin in venting service on alum digesters at Cyanamid's Warners plant. The carbon steel breech (left) in an alum evaporator required frequent maintenance, failed after less than three year's service. Glass-reinforced LAMINAC stacks (right) in even more severe alum digester service, have needed no maintenance in more than three years. The LAMINAC units cost less in the long run, and were easier to erect and assemble, using either telescope joints wrapped and polyester-welded on the site, or flange-type joints.





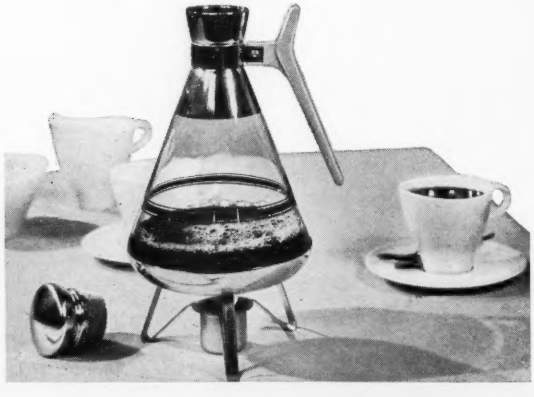


ATTRACTIVE, AIRTIGHT CASE FOR STICK COLOGNE

Six new scents of Avon Stick Cologne are packaged in smartly styled, practical cases molded of BEETLE® urea molding compound. Cases have a white base with contrasting closures in a different color for each scent. Airtight, the BEETLE case stops evaporation of the cologne. Yet the closure opens easily, and with a twist of the wrist the stick pops up for use. The case resists alcohol, essential oils and chemicals as well as staining from perspiration and grime, which wipe off easily.

FUNCTIONAL HANDLES GRACE CARAFES

Any dining or buffet table would be graced by this attractive carafe with its stylish, beige-colored handle molded of CYMEL* melamine molding compound. Elegance and function are combined in the handle, balanced for easy, comfortable pouring. Harmonizing with the carafe's gold decoration, the molded-in color won't chip or wear off. In keeping with its function, CYMEL is exceptionally strong, resistant to heat and flame, and stays cool even when the carafe, made by Club Aluminum Products Company, is full of hot coffee. *Trademark



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PLASTICS AND RESINS DIVISION
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MATERIALS FOR TOMORROW

A complete tubing service working for you

- **DESIGN ENGINEERING**
- **MANUFACTURING**
- **QUALITY LAB-TESTING**

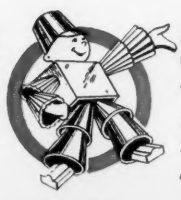
Standard Tube & T. I. have a fully experienced group of design engineers who will work with you in the designing of new products or the improving of existing ones.

Modern manufacturing facilities and thousands of man years of tubing experience have made Standard Tube & T. I. the largest fabricator of welded steel tubing in Canada.

Quality is important at Standard Tube. To keep quality at its highest, a completely equipped laboratory makes continuous tests ranging from analysis of the raw stock to examination of in-use operation of finished pieces.

STANDARD TUBE STANDS FOR ALUMINUM, TOO!

Sheet, Bar, Extrusions, Tube and Wire—available in any quantity.



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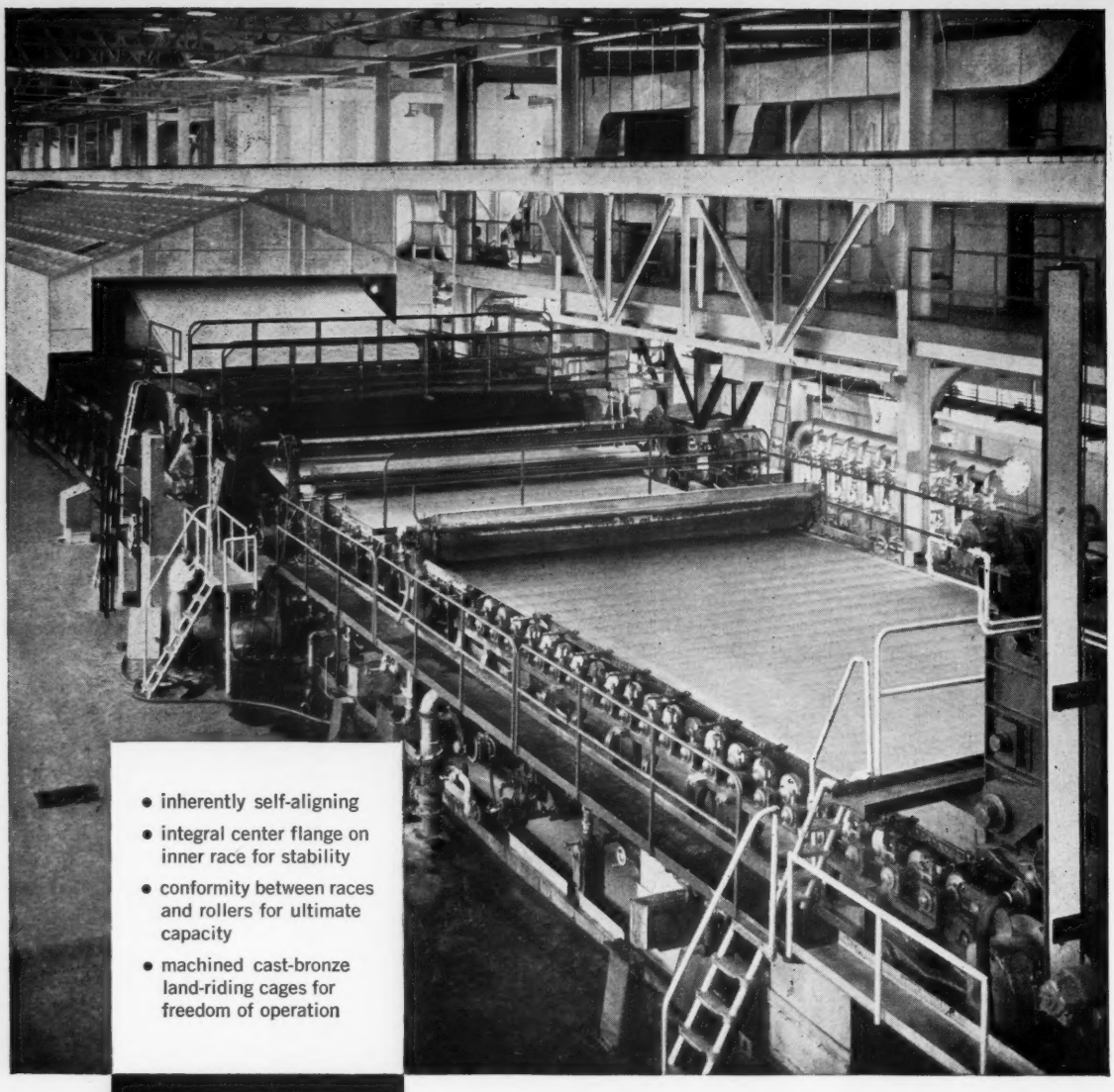
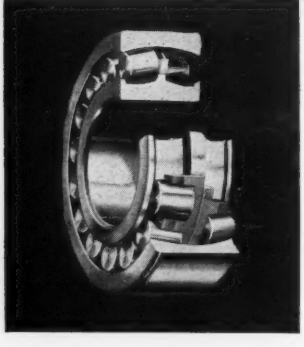


- inherently self-aligning
- integral center flange on inner race for stability
- conformity between races and rollers for ultimate capacity
- machined cast-bronze land-riding cages for freedom of operation



A New World's Record!

World's record on 50# Kraft bag paper—2,200 fpm—is held by this 232-inch paper machine built by Beloit Iron Works for St. Regis Paper Company at Jacksonville, Florida.

Contributing to this performance are 718 Torrington Spherical Roller Bearings on wire rolls, press felt rolls, top press rolls, paper and felt driers and idlers, calenders, suction couch and press rolls, reels and winders. Inherently self-aligning, these bearings compensate for shaft deflection across the machine and eliminate need for periodic realignment.

Torrington Spherical Roller Bearings are available from stock with straight or tapered bores for shaft or adapter mounting. When you are counting on production, count on Torrington Spherical Roller Bearings for smoother, faster, more economical service from wet end to winder.

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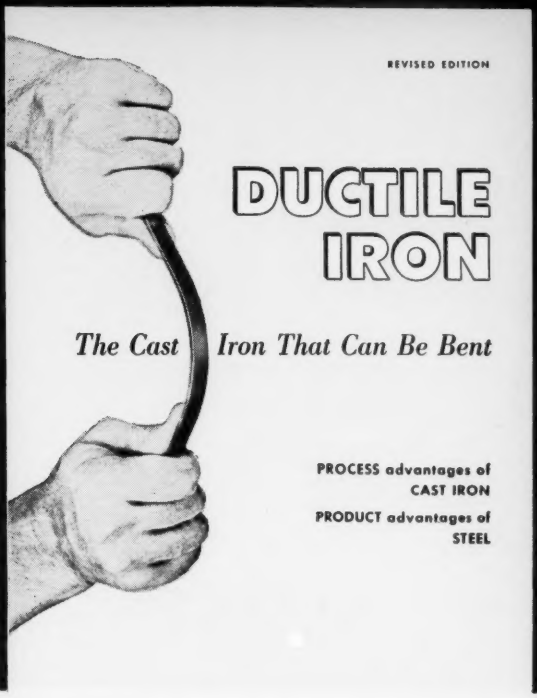
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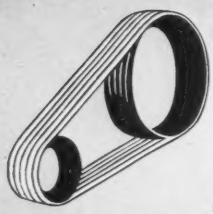

DRIVES

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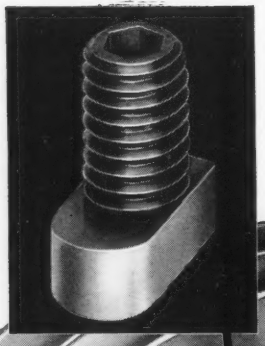
- positive locking
- greater design hp capacity



HERE'S THE KEY. This combination keylock from disc to hub makes adjustment easy.

Here's an entirely new Allis-Chalmers concept in cast iron adjustable sheave design. It's the newest member of the *Texrope* drive family, the *Magi-Key* sheave!

This new sheave makes it really easy and inexpensive to obtain variable speeds on low-horsepower applications. Here's why:

✓ Handles design horsepower applications from fractional to 13 hp.

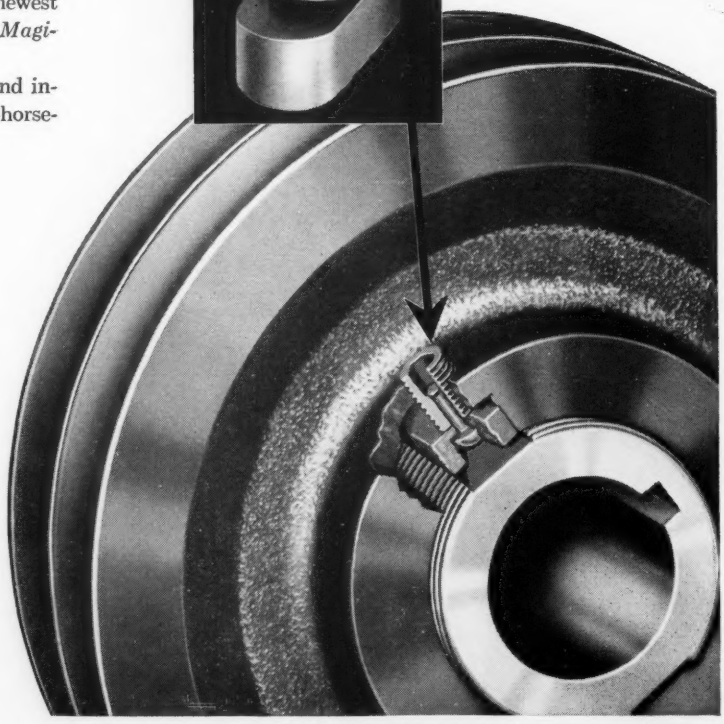
✓ Features positive locking between sheave and shaft.

✓ Has combination keylock from disc to hub . . . no more fumbling to get proper tightening.

✓ All rotational torque transmitted through keys.

✓ Key lock won't slip — setscrew can't fly out.

Magi-Key sheaves are available in one and two-groove sizes for either A or B section V-belts. Find out more from your A-C district office or distributor, or write Canadian Allis-Chalmers Ltd., P.O. Box 37, Montreal, Que.



MADE IN CANADA

CANADIAN ALLIS-CHALMERS

New trends and developments in designing electrical products . . .

How General Electric Permanent Magnets help designers miniaturize products by supplying constant magnetic field energy in a fraction of the space required by electromagnets

WHERE constant magnetic field energy is necessary, powerful G-E Alnico permanent magnets offer the designer many advantages no electromagnet can match.

The most important of these advantages – from the designer's viewpoint – is the permanent magnet's superior volumetric efficiency. An Alnico permanent magnet can supply a given magnetic field in a fraction of the space required by even the best designed electromagnet.

Since miniaturization has become so vital in the electrical and electronics industries, it is important to see just why and how a permanent magnet utilizes space so much more effectively.

Figure 1 shows a typical magnetization curve of an electromagnet with a flux density of 20,000 gausses, when the polarizing force is 200 oersteds. (The curve has been displaced into the magnetizing quadrant for comparison purposes.)

In a well-designed electromagnet, approximately half the total area is occupied by conductors, and half is flux-conducting core material.

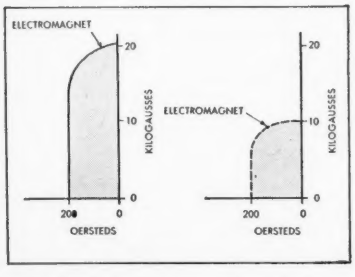


FIGURE 1

FIGURE 2

Therefore, to make the comparison valid, the residual induction of the electromagnet must be reduced to 10,000 gausses (Figure 2).

The area under the curve now represents the approximate external field energy available on a volume basis. When the equivalent demagnetization curve of Alnico 5 is plotted against the corrected electromagnet curve (Figure 3), the true capabilities of each type of magnet become immediately apparent.

The area under the Alnico 5 curve is about three times the area under the electromagnet curve. Thus, to produce a given field requirement, the permanent magnet will occupy a volume one-third that of an equivalent electromagnet.

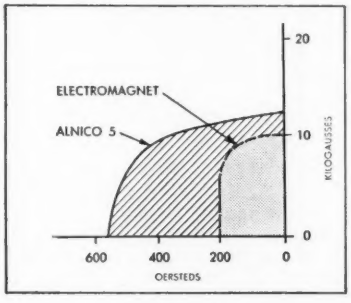


FIGURE 3

The above comparison is somewhat theoretical; under many circumstances, permanent magnets will show to even greater advantage. For example, consider the two TV-tube focusing magnets in Figure 4, at the top of the next column.

At the left, is the electromagnet previously used. It weighed 2 lbs. 13 ounces, and took up 16.35 cubic inches. At right, is the G-E Alnico 5 permanent magnet which replaced it. The new magnet weighs just 15 ounces, and occupies only 1.30 cubic inches – a space saving of 87%!

These savings in size and weight result from permanent magnets' inherent volumetric superiority. In addition, permanent magnets provide equally impressive savings in both initial and service costs because of four other inherent advantages.

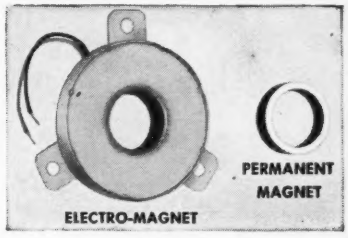


FIGURE 4

First, no power source is required with permanent magnets, because no energy is consumed. Once magnetized, the field is permanently retained.

Second, permanent magnets operate continuously. There can be no interruptions of the field due to power failure.

Third, permanent magnets are extremely stable under changing temperature conditions. They are unaffected by conditions ruinous to electromagnet installations.

Fourth, permanent magnet assemblies are easier to install, and cost nothing to maintain. There are no moving parts to break down, no wiring to burn out, no costly, time-consuming repairs to make.

These are but a few of the many reasons why designers are turning to G-E Alnico magnets for products for which only electromagnets had been previously considered.

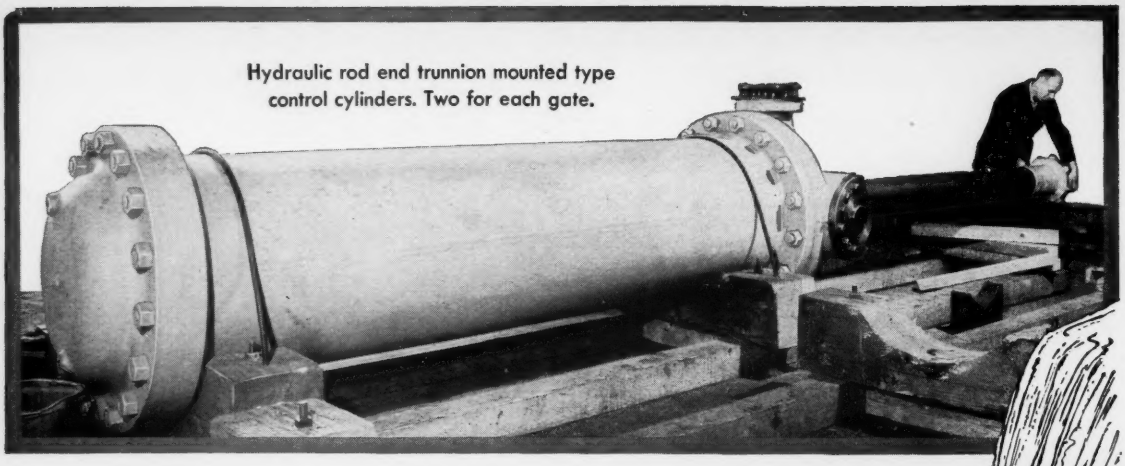
If you have a problem where constant magnetic field energy is required, one of the G-E Alnico compositions may well be your solution. For more design data or technical assistance from our magnet engineers, write: *Permanent Magnet Section, Canadian General Electric Co. Ltd., 940 Lansdowne Ave., Toronto 4, Ontario.*

Permanent Magnet Section

INDUSTRIAL PRODUCTS DEPARTMENT

462W-157

CANADIAN GENERAL ELECTRIC COMPANY LIMITED



Hydraulic rod end trunnion mounted type control cylinders. Two for each gate.

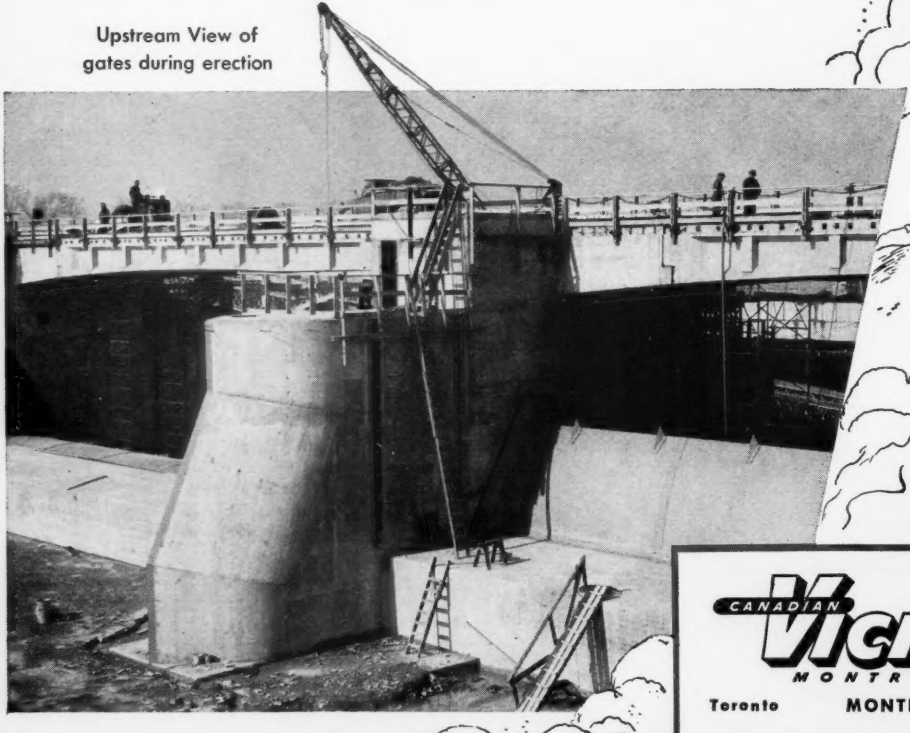
CONTROLLING THE FLOW OF NIAGARA

The flow of Niagara, one of Canada's greatest sources of electric power, is controlled by Vickers-built submersible gates of the "fishbelly" type.

Working with the M.A.N. Company, a Canadian Vickers associate, who designed the 100 ft. wide section welded gates, thirteen gates were supplied along with twenty-six servomotors and thirteen pumping sets which were entirely engineered by Canadian Vickers.

These gates are another example of the precise engineering that goes into all Vickers-built water control equipment.

Upstream View of gates during erection



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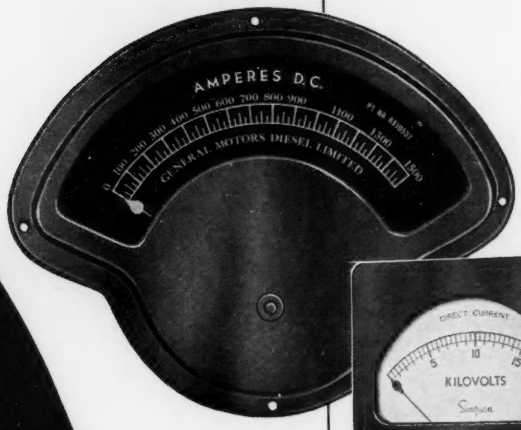

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Special ranges and dials available to any manufacturer's specifications.

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Totallizes elapsed time in up to five digits with two available ranges — 99999 hours or 9999.9 hours. A useful instrument to indicate the total time the electrical equipment has been in service. Three case styles to match other Simpson Instruments.

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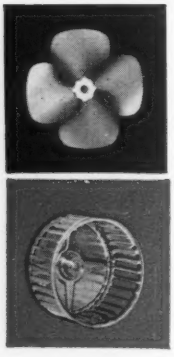
NEW & NEW & EQUAL NEWS



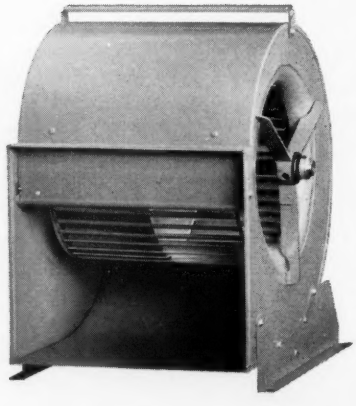
It's the *new* Torrington line of Vari-Basic blower units for central heating and air conditioning equipment, now in production at all three Torrington plants. And here is why this important product development is *news.*

1. New quality: Engineering features include the famous Center-Lock Airotor wheel design . . . permanently plastic lubricated Randall bearings, with 3-point suspension . . . and spot-welded heavy steel construction, superbly finished.

2. New flexibility: The units are designed for interchangeability with existing standard equipment, and Torrington's marketing policy makes these components available singly or in combination.

3. New versatility: These units are available in a wide range of sizes designed to provide maximum variability to meet directional-flow requirements.

Your inquiries are invited. For full information, *talk to Torrington!*



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People

Important people who are in the news

International Equipment
This company announces two recent appointments of interest to our readers. One is **J. H. Miller, B.A.Sc.,** who becomes general manager of the Napanee Iron Works. The other is **W. Naves, B.Eng.,** who is appointed engineer to the same works.

Linde
J. Gordon Roy has been appointed assistant to the sales manager, distributor products, at Linde Air Products. He was formerly assistant manager of the accounting department.

BRICK

A man who stayed
For more than half a century of service with Canadian Westinghouse **Robert Brick** worked on the assumption that "you can always learn something new about a job." He has just retired after the longest service ever recorded with the company — 52 years.

Although he holds no university degrees, he is an authority on commutators for electric generators and motors and was often consulted by engineers contemplating design changes in his line of work.

He joined the company in 1905, less than two years after it was organized in Hamilton and his early months were spent making tools and fixtures as the Westinghouse Air-Brake firm prepared to enter the electrical apparatus field.

Canadian Applied Research
Eric B. Moss, 55, has been appointed director of engineering of the newly-named Canadian Applied Research of Toronto. Since 1953 he has been technical director of Smiths Aircraft Instruments Ltd., the UK firm.

Canadian Steel Improvement
Two new appointments at CSI. Firstly, **R. G. Murley.** Mr. Murley becomes the company's export manager to handle an export business that has grown substantially in the past few years. He gained experience in this field when associated with High Duty Alloys, a member of the Hawker-Siddeley Group.

Secondly, **Mr. F. Bruce Pillman.** His appointment is that of Canadian sales manager. He was formerly with the Ford Motor Co. of Canada Ltd.

Hunting and PSC
Roger W. Hutchins has been appointed executive assistant to Douglas W. Kendal, founder and operating head of the Hunting Canadian Companies. A graduate of McGill University in mathematics and physics, Mr. Hutchins was Montreal plant manager of Federated Metals Canada Ltd. He served in the last war with the RCNVR in the North Atlantic.

R. A. Brocklebank has been appointed chief engineer, surveys and mapping, of the Photographic Survey Corporation of Toronto, a Hunting Canadian company.

He brings to his new assignment five years of experience gained in supervising control surveys on large PSC projects in Peru, Venezuela and the West Indies as well as on mapping and engineering projects throughout Canada. He is a civil engineering graduate of the University of Toronto and belongs to the Ontario Association of Professional Engineers, the Engineering Institute of Canada and the American Congress of Surveying and Mapping.

Atlas Steels
Mr. Harold B. Chambers will head all metallurgical functions within Atlas Steel following his latest appointment to Director of Metallurgy with the company.

SKF
Nils F. Kallin has been elected president of Canadian SKF. He has held positions with SKF in several countries and was managing director of the company's Tokyo, Cairo and Shanghai affiliates for many years.

Swedish-born Kallin takes over from **Gunnar Westar** who is now chief executive of the organization's plant in Schweinfurt, Germany.

Four Wheel Drive
W. L. Pressé has been appointed a district sales manager for this Kitchener, Ontario, company. He will work with FWD dealers in Quebec, New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland.

MULLER-MUNK

World design society
Pittsburgh designer **Peter Muller-Munk** has been named the first president of the International Council of Societies of Industrial Designers following an organizational meeting held in London.

Other officers include Mischa Black of London, first vice-president; **Enrico Peressatti** of Milan, second vice-president; and **Pierre Vago** of Paris, secretary-treasurer. All offices will be held for a two-year period.

CHAMBERS

KALLIN

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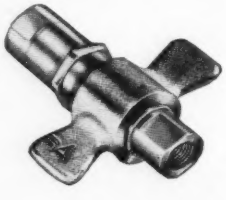
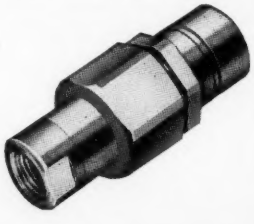
HIGH PRESSURE LINES—Double Wire Braid 1509 Hose for high pressure hydraulic, grease, crude and fuel oil, gasoline and air lines. In sizes from ¼" to 2"; pressures up to 5000 psi., depending on size; temperature range —40°F. to +200°F.

LOW PRESSURE LINES—Aeroquip 2556 Hose and *SOCKETLESS* Fittings for low pressure oil, fuel and air lines on all applications. In sizes from ¼" to ¾"; for pressures up to 250 psi., temperature range —40°F. to +250°F. *SOCKETLESS* Fittings in male pipe, S.A.E., J.I.C. threads. (Patent applied for.)

HIGH TEMPERATURE LINES—2802 Hose (Teflon) and Reusable ***"super gem"*** Fittings for fluid systems subject to high temperature and corrosive fluids. Hose and fittings can be assembled with ordinary hand tools. In sizes from ¼" to 1"; for pressures up to 1500 psi.; temperature range —100° F. to +500° F.



SELF-SEALING COUPLINGS—Type 5100 (wing union nut) and Type 5110 (hex union nut) allow quick connection and disconnection of fuel, oil, hydraulic and air lines, replaces two shut-off valves. There is no loss of fuid or inclusion of air into the system on connection and disconnection of fully pressurized lines. In O.D. tube sizes from ⅛" to 1½"; for pressures up to 2000 psi.; temperature range —40° F. to +250° F.



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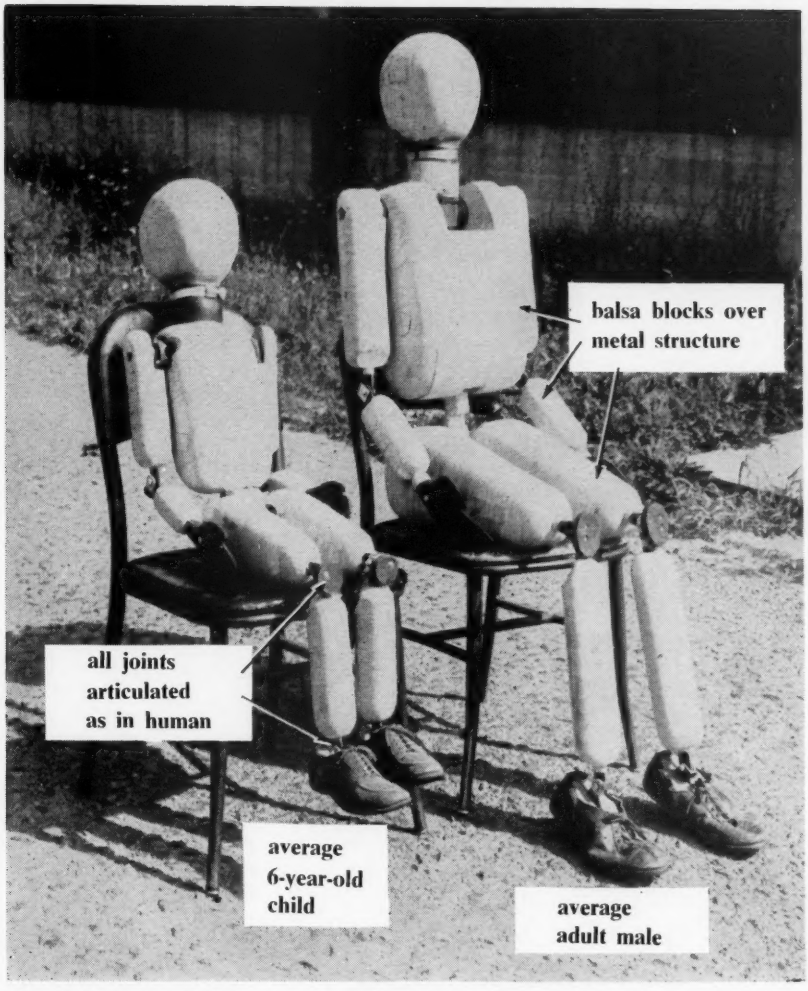


Hundreds of us will die in our cars today—every day. Dummies help us find a cure.

Why doesn't the auto leave us alive?

By John W. Dennis ASSISTANT EDITOR

Attempts are under way to make the man-killing auto a safer crash package for egg-frail human contents

No one who has seen a serious automobile accident ever forgets the grotesque sight of a human body, after high impact, reduced to a tattered rag doll.

Man, unable to exceed 23 mph without mechanical assistance, is simply not packaged to survive the collision speeds to which the automobile has introduced him and the process of evolution can't catch up and adapt him. Remember, the composition of the human head closely matches the ordinary hen's egg.

In case later remarks in this article might seem to be overstating the case for crash-proofing, it is worthwhile at this point to trot out a few cold statistics. They

are based on data provided by the Indiana State Police who estimate that only 16% of fatal car accidents in country districts could be classed as non-survivable. 18% were severe enough to be debatable. The remaining 66% of fatal smashups were clearly survivable. 45% of all the fatal accidents occurred at speeds **under** 40 mph.

How does this last statistic tally with the fact that stunt drivers can crash their cars at similar speeds and walk from the wreck unhurt?

The stuntman drives from the rear of the passenger compartment and, just before impact, ducks behind the front seat and braces himself against the seatback. This prevents him from being thrown against the dangerous dash and windshield area and he can make full use of the cushioning in the collapse of the forward structure. The average driver has no such protection. In a collision he is like an unrestrained egg in a lunch pail.

The answer to the growing highway toll is not to be found in reduced speed alone. It depends equally on rendering the car a safer container in which to crash. Is anything being done?

The Cornell Laboratory, a non-profit affiliate of the well-known university, has conducted an elaborate research program for the Liberty Mutual Insurance Company of Boston and has come up with an interesting design which goes a long way to making the car a package that won't assassinate driver and passengers in a collision.

First step in their work was to get an exact idea of what happens to the human body in a crash. This was done by making life-size dummies of metal and balsa, hinged to follow a man's joints. A two-door car was equipped so that it could be decelerated (as in a crash) without becoming a total wreck and so withstand repeated experiments. High-speed movies recorded the movements of the victims.

Villains-in-chief as far as the driver was concerned were the chest-spearing steering column and the upper windshield. The front seat passenger struck the upper windshield and headliner first—then the dash panel. The movements of rear seat passengers were unpredictable (one dummy struck the windshield heavily and fell back into the rear seat) due to the greater distances traveled. Investigators learned that crashes at speeds as low as 17 mph could prove fatal under the worst possible conditions*.

Upshot of their research was the Liberty-Cornell car shown in the drawing. Some of the unusual design features (many of them radical) are plainly visible; others are less obvious in this car which, externally only, adheres to the popular conception of how a car should look.

Driving is done from the centre of the car where visibility is best and the driver away from the much-favored offside front impact area. Both the driver and the two front passengers are held in position in the cab by yoke-like devices which pull rearward after they are seated. The control panel is integral with these retaining hoops and the steering wheel has been completely eliminated in favor of a hydraulic, lever-controlled system parallel to the floor; the whole unit is cushioned to distribute chest impact forces. Another feature of the panel itself is its color-coded system.

*A 10-lb human head can take a blow equal to a drop of not more than 40 in. onto a hard surface without injury.

Seatbelts don't eliminate a skewered chest but will greatly lessen danger and prevent a skull fracture.

In 17mph crash adult dummy is heading through windshield. Child's head has struck back of front seat.

Most obvious departure in the Liberty-Cornell car is the seating arrangement and driver's control panel.

(Continued on page 80)

Taking a close look at hot materials

Such microscopy allows the direct observation and photographic recording of each small transformation

By S. J. Majka ONTARIO RESEARCH FOUNDATION

Many methods have been developed for the investigation of transformations taking place when metals, alloys and non-metallic materials are heated.

The transformations may be observed when they actually happen or later, after the specimen has been cooled. The results obtained by most of the methods are an integration of the transformation effects produced by all constituents present in the specimen. Often, important reactions due to small particles escape attention.

In comparison with other methods, high temperature miscroscopy allows for direct observation and photographic recording of all transformations, even those within a single small particle. The method is limited to reactions accompanied by structural changes resolvable under available magnifications. The direct microscopical observations of transformations in metals at elevated temperatures was reported several decades ago, but due to experimental difficulties (and to the inadequacy of available equipment) this interesting technique did not find the deserved wide application.

Although many ingenious designs have been described in technical literature, the equipment is produced commercially by only a few manufacturers following two distinctly different principles.

For the moderate requirements of metallography and for a large number of problems encountered in mineralogy and chemistry (where small specimens are used and temperatures not much in excess of 1,000 C are sufficient) standard microscopes, equipped with stage furnaces, are quite satisfactory. In addition to a microscope and a stage furnace, the basic equipment consists of a vacuum unit and often a protective gas supply, a temperature indicator (or recorder) and a manual (or automatic) temperature control assembly.

In ceramics, chemistry and sometimes metallurgy, large specimens and temperatures well above 1,000 C are frequently required. Therefore, the optical system of the microscope must be modified and located at a considerable distance from the examined surface. The furnace itself becomes complicated and bulky. The components of the entire assembly must be matched together or pitfalls may be expected.

In all instances when photographic recording is desirable a miniature film camera is preferable, for it allows a large number of exposures to be taken in quick succession. Often there is no opportunity of repeating faulty exposures and consequently a reliable high sensitivity exposure meter (suitable for microscopy) is essential. Time-lapse motion pictures are also frequently taken with considerable success.

The optical system of a microscope used with a small stage furnace generally remains unchanged (at least for work in the lower magnification range) and the furnaces may be conveniently located on stages of both vertical and inverted microscopes. In both in-

High temperature microscope with stage furnace and vacuum system. Temperature recorder not shown here.

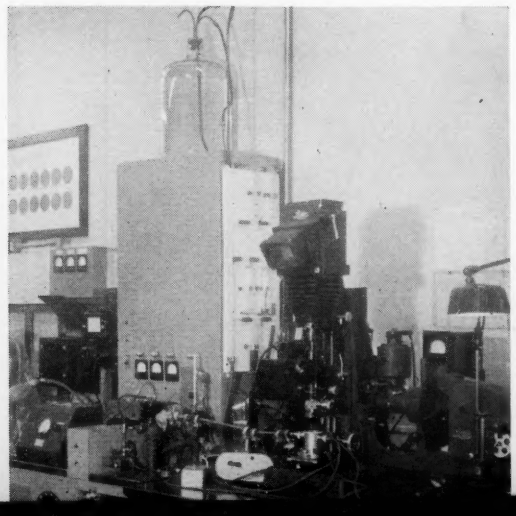
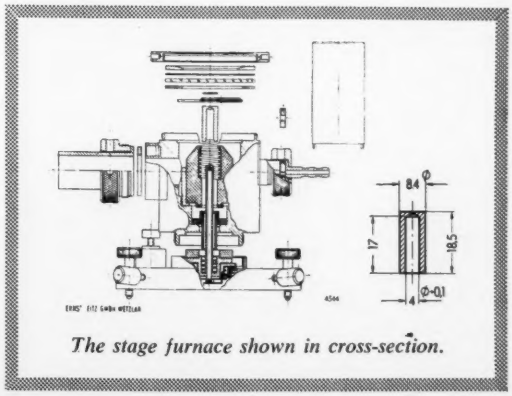
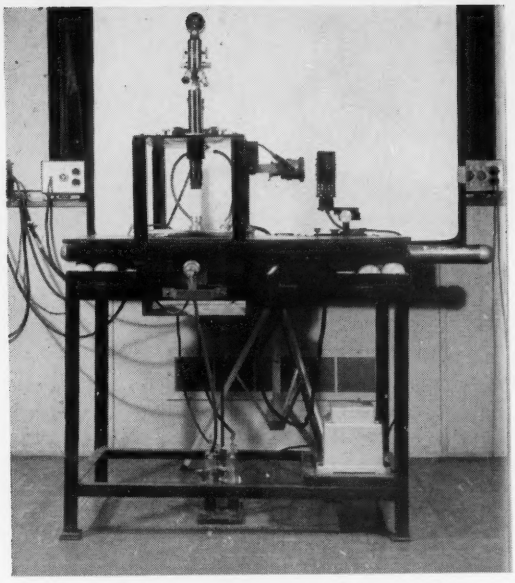


Illustration from a 200 power magnification showing surface liquations at 900 degrees C. Bright field.



The stage furnace shown in cross-section.



A low power furnace microscope. The conventional microscope, relay lens and illuminator are located above table-top level and the furnace suspended below it.

stances, no major mechanical modifications of the stages are necessary.

The surface of the specimen (which is enclosed in the sealed, vacuum or protective gas furnace) must, however, be examined through a quartz or special glass plate covering the specimen chamber. As all standard objectives are corrected for a definite small thickness of the cover glass (or designed for use with no glass cover) the presence of the thick furnace window adversely affects the quality of the image. With low-power conventional objectives, the distortion is negligible and the resolution of details remains satisfactory. Reflections due to the window, however, may be expected to produce uneven illumination and caution is required in the use of both the aperture and the field stops. The working distance of low-power objectives is in most cases adequate, and generally no special cooling of the objective body is necessary. When using conventional objectives, good results may be expected at magnifications up to about 200 diameters. At higher magnification, the quality of the image falls short of the ideal.

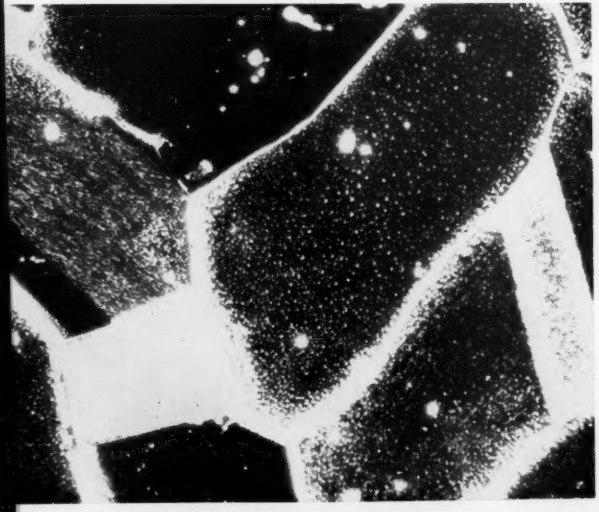


Illustration from 200 power magnification of surface attack by gases. 700 degrees Centigrade, dark field.

For work in the range of 200 to 500 diameters, special objectives combining sufficient working distance and adequate numerical aperture are required. While the distance between the objective and the specimen enclosed inside the furnace chamber remains adequate for safe operation, the objectives ensure good resolution of minor structural details.

Refracting, reflecting and combined long-distance objectives are commercially available. Refracting objectives are generally inexpensive and up to 0.25 numerical aperture do not require correction for furnace window plate. The objectives may be considered entirely satisfactory for work in the 200 to 300 dia magnification range. When still higher magnifications (up to 500 dia) are called for, reflecting objectives are preferable. The resolution and quality of the images produced by these objectives are very good, provided the systems are corrected for use with the furnace window and for the microscope tube length.

Some of these objectives primarily designed for ultra-violet microscopy include components joined together by cements of comparatively low melting point. When used for examination of specimens heated to temperatures in excess of a few hundred degrees centigrade, adequate artificial cooling of cemented components (usually by air blast) must be provided. As the optical system is composed entirely of mirrors, the objectives are bulky and require very careful handling. Recent literature reported custom-made reflecting objectives designed for high temperature microscopy with numerical apertures up to 0.7. Such objectives extend the magnification range of high temperature microscopy to over 700 dia without reducing the quality of the image. These objectives are, as far as the writer knows, not yet commercially available.

Both refracting and reflecting long-distance objectives are suitable for use with transmitted and incident light, without modification of the illuminating systems.

In a combined objective, a spherical mirror focuses a real image of the examined surface in the focal plane of a conventional objective mounted concentrically with the mirror. Resolution of detail is good and the systems are inexpensive and sturdy. Combined objectives used with normal vertical illuminators produce excessive glare; they are, however, satisfactory for high temperature microscopy in transmitted light.

Most of the work published was done under bright field illumination, which remains the principal technique. It is possible however (at least in the lower magnification range), to use imperfectly polarized light and dark field, without difficulty.

To avoid oxidation of the polished surface, the specimen (usually of a standardized form) is heated in vacuo or in a protective atmosphere under reduced pressure.

Although many different kinds of stage furnace have been constructed (some of them very ingenious) for special purposes by a number of research institutions, there is little to select on the market. Most of the available furnaces are designed for use with a vertical microscope, a system proved to be of advantage for both

Continued on page 94

This water meter (in detail in "Ideas round-up") uses Alnico permanent magnets to activate its sealed register.

Magnets take on a greater permanence

Magnet materials can trace their ancestry back to China in 2700 BC

Cutaway view of a high fidelity loudspeaker shows an Alnico V permanent magnet as positioned in the unit.

Steps in improving permanent magnet materials had to await the discovery of magnetic and electric phenomena that made the measurement of magnetic values possible. The brilliant work in the early part of the 19th century by many men (among whom were Oersted, Ampere and Faraday) indicated the relationship between electricity, magnetism and ferro-magnetism. Through this information it was possible to develop devices for measuring the electrical and magnetic values so necessary for improving permanent magnet materials. Around 1880 the first marked improvement in permanent magnet steel was made through the addition of tungsten; during World War I chromium was substituted for tungsten. Shortly after this, spectacular results were obtained by adding cobalt. The resulting cobalt steel held a prominent position among magnetic materials until about 1934, and even today is still used for some applications.

In 1931, as the result of investigations by Prof. Mishima in Japan, the entire outlook on permanent magnet materials was changed. It was noted that certain alloys of iron, nickel and aluminum possessed exceptional magnetic properties. These alloys (known as the

The field of this article

In recent years there has been a tremendous increase in the number of applications for permanent magnets. Development of new and improved magnetic materials has been responsible for much of this growth.

This article gives a brief historical background and reviews the permanent magnet materials now available to the product designer.

Alnicos) introduced a new era of permanent magnet materials.

Intensive investigation has continued over the years and there are now seven distinct grades of Alnico, some of which contain cobalt and titanium. This research has resulted in an increase in the peak available energy of magnetic materials more than 30 times that of carbon steel.

In the process of searching for alloys with higher available energy, combinations of metals were investigated that revealed other interesting properties, both magnetic and physical.

Among these were alloys with a high copper content, and also alloys with silver or platinum. The outstanding feature of this work was the development of magnetic materials that are ductile and malleable.

Only recently has a new and completely different magnetic material been introduced. It is a ceramic with many of the physical properties of ceramics in general. Although the available energy of this material (it is a compound of barium carbonate and iron oxide) is not as great as that of the Alnicos, its exceptionally high coercive force, light weight and high resistivity have made its use very promising.

The Alnicos

All the Alnico alloys have high coercive force and high magnetic energy. They are composed of aluminum, nickel, cobalt and iron while some grades also contain copper and titanium. Each of the various grades exhibits certain advantages and certain limitations. Grades V and VI (see table) have directional characteristics; that is, the magnetic properties are much better in one preferred axis. This effect is obtained by cooling the magnet from the normalizing temperature (about 1300C) to black at a controlled rate in a strong magnetic field. This magnetic field must be of the same configuration (or approach it as closely as possible) as that desired in the finished magnet. Polarity is not important, but the axis of magnetization must be the same as that desired in the finished magnet. After this, the magnets can be demagnetized and remagnetized in the usual manner. It must be realized that, due to the high field strengths required and the high temperature of the material during the cooling stage, there are limitations to the shapes and sizes of these magnets.

Cast Alnico

All grades of these magnets are produced commercially by sand casting to the desired shape; grades II, IV and VI can also be produced by sintering.

The material, especially in cast magnets, is brittle and mechanically weak. It cannot be rolled or formed either hot or cold and it is not machinable. Any necessary finished surfaces are therefore obtained by grinding. For this reason, "as cast" tolerances should be employed wherever possible. Tolerances for sand-cast magnets are:—

Up to 1 in.: 0.015 in.
1 in. to 4 in.: 0.032 in.
4 in. to 6 in.: 0.045 in.

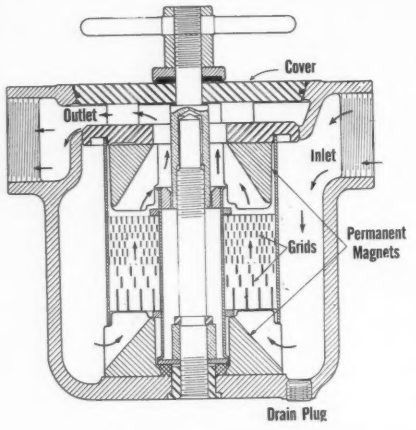
Required holes may be made by suitable cores at he time of casting and in many cases it is practical to introduce inserts of mild (or stainless) steel at the time of casting. These can be drilled, tapped or otherwise machined after final heat treatment. Generally, these inserts have locking features such as heavy knurls.

Because Alnico has a very high shrinkage from the molten state, approximately 11/32 in. per ft is allowed in patterns; and because of a low tear strength, the section about the insert must be adequate to prevent excessive cracking. In all cases, avoid thin sections, an abrupt change of section and sharp internal corners.

The actual production of the cast form is highly specialized. The accurately proportioned metals are melted in high-frequency electric induction furnaces and the temperature accurately controlled. After pouring, the castings are allowed to cool to room temperature. The permanent magnet characteristics are developed by

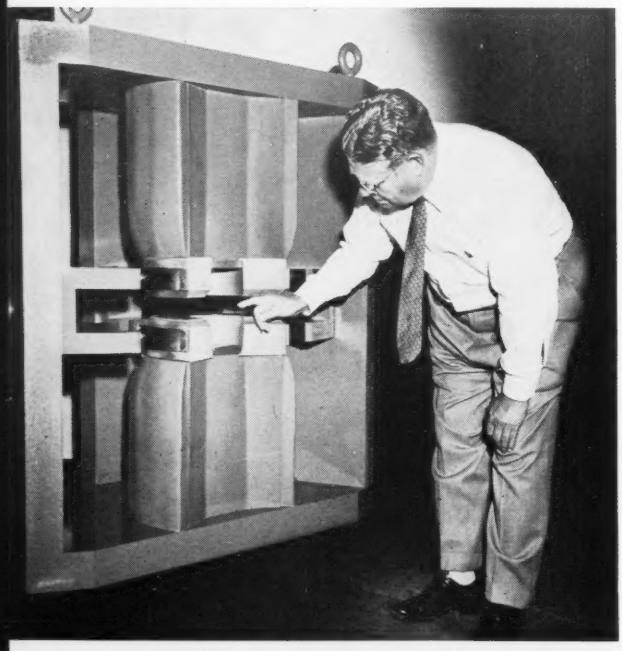
Alnico V magnet in this direct drive chain saw helps produce the hot spark required in low speed running.

All grades of Alnicos are produced commercially by casting to shape



Magnetic separator

Cross-sectional view of a device designed to remove metal particles from coolants.



A giant 4,700 lb magnet assembly with a maximum field strength equal to 10 tons of magnetic holding force.

heat treating, which consists of cooling from a temperature of 1,000 to 1,300 C at a controlled rate to below 600 C, followed by an ageing treatment at temperatures from 550 C to 700 C. The exact time and temperature for each operation depends on the grade.

Sintered Alnico

The sintering process (which can be applied to Alnico II, IV, V and VI) consists of thoroughly mixing powders of the various ingredients together. This mixture is pressed in dies to the desired shape and then put in a furnace, which has either an atmosphere of dry hydrogen or a vacuum. The correct temperature is maintained until fusion of the particles is achieved, thereby making the magnet into a homogeneous whole. Heat treatment is similar to that with cast magnets.

The magnets made by sintering are fine-grained and have greater physical strength than cast materials. It is possible to hold tolerances closer than with sand castings. Any finishing required must be done by grinding. In some cases, steel inserts can be sintered in place.

This sintering process is especially suitable for small magnets of less than 1/20 lb. Magnets intended for production by this method must be designed to permit pressing in one direction. This means that the contour of the magnet (and any holes therein) must be parallel to the direction of pressing. Preferably, the section should be uniform along the direction of pressing. Extreme variations of section in the direction of pressing should be avoided because the powder does not flow.

Bevels should be avoided, for they shorten die life and add to the cost of manufacture. The limit of length in the direction of pressing is approximately three times that of the minimum cross section.

Although surfaces can be ground to closer tolerances, normal "as sintered" tolerances are:—

Up to .125 in.:	±.005 in.
.125 in. to .625 in.:	±.010 in.
.625 in. to 1.250 in.:	±.015 in.

Sintered magnets are normally furnished in three grades. Grade II for general purpose applications and grade V or grade VI for high energy applications. However, when grades V and VI are used, careful consideration should be given to the magnetic design, because of the directional properties of these materials. In general, the magnetic properties of the various grades of sintered magnet are approximately 10% less than those of equivalent grades of cast Alnico.

Indox

Ceramic magnets (such as Indox) are unusual because they are not metallic like practically all other permanent magnets. Being ceramic, they have many of the physical characteristics of the materials in the ceramic family, and are hard and brittle. They are nonconductive and much lighter than metallic magnets. These properties (together with certain superior magnetic characteristics) have made them particularly desirable in many applications.

The basic ingredients of barium ferrite magnets are

Ceramic magnets are powder-formed

processed to provide a powder with particles of smaller than critical size. This powder is then pressed under high pressure to the required shape in a die. The resulting compact (which is fragile) is sintered in a special furnace at high temperature. During this process, the compact shrinks on all dimensions to approximately ⅞ of the pressed size. The ceramic magnet cannot be drilled or machined; it can, however, be finished by grinding.

Ceramic magnets may be demagnetized by heating above the Curie temperature (about 460 C). These magnets should be heated and cooled slowly (at about 100 C per hr), for the material is brittle and susceptible to breakage from thermal shock. Ordinary demagnetizing coils are not sufficiently strong to provide the necessary field.

There are a number of advantages associated with this new ceramic material. Among these is the fact that no critical materials (such as cobalt and nickel) are required. The basic ingredients (barium carbonate and iron oxide) are low-cost and readily available materials.

Ceramic magnets have the highest coercive force of any commercially available magnets. This makes it practical to have much shorter magnet lengths than are possible with other materials, with a corresponding increase in magnet area due to the lower flux density. Magnets may be magnetized before assembly, for there is no significant loss in magnetism from being subjected to open circuit, as occurs with most other materials. This permits the design of magnetic circuits which might otherwise be impossible with materials requiring magnetization in place.

The electrical resistivity of a ceramic magnet is such that it is classed as a non-conductor. Eddy current losses (and associated heating effects caused by alternating fields) are extremely low. Use of ceramic magnets can introduce a weight advantage over previous materials since its specific gravity is only 4.7. The cast Alnicos average about 7.0.

The energy product of ceramic magnets is 0.95 x 10^6, which is somewhat below that of the Alnicos. The coercive force is 1600 oersteds, as compared with 950 for Alnico XII, which is the highest of the group.

A new, high energy ceramic magnet introduced by Indiana Steel Products earlier this year has an energy product of 3.5 x 10^6 and a coercive force of 2,000 oersteds. It is called Indox V.

Vectolite. This ceramic magnetic material is composed of oxides of iron and cobalt. It has an energy product of 0.6 x 10^6, with a coercive force of 1,000 oersteds. It has been replaced by barium ferrite magnets because of higher values and lower cost.

Cunife I. Is an alloy containing approximately 60% copper, 20% nickel and 20% iron.

The magnets are produced by severe cold reduction, which produces superior magnetic properties in the direction of rolling. The magnetic properties of Cunife compare favorably with those of Alnico III. Optimum magnetic properties are obtained when the magnets have

PERMANENT MAGNETS

Comparison of available grades:

Alnico Grade

I Is magnetically similar to Grade III but is generally preferred for larger size castings. Alnico I is a general non-oriented grade having a typical composition of Al-12%; Ni-20%; Co-5%; Fe-63%. A normal value for the peak energy product of Alnico I is 1.4 x 10^6 oersteds.

II Has the highest peak energy product of any non-oriented Alnico at slightly higher cost. It is in the range of 1.6 x 10^6. This grade is especially useful for shapes in which it is difficult to achieve the directional properties of Grades V or VI. The composition, in general, is Al-10%; Ni-17%; Co-12.5%; Cu-6%; Fe-54.5%. Sintering is frequently employed because it is the most practical method for making small magnets.

III Is the lowest cost Alnico alloy per pound. It contains no cobalt. The usual composition is Al-12%; Ni-25%; Fe-63%. Sizes are limited to comparatively small cross-sections.

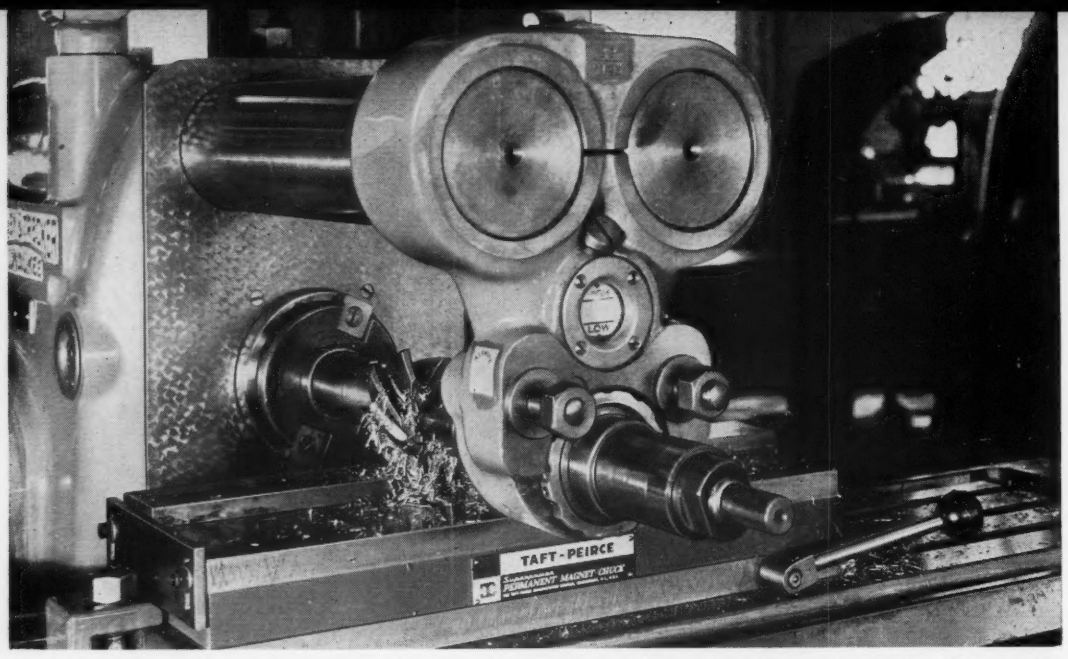
IV Has the highest coercive force of any of the nonoriented Alnicos except Grade XII. The typical composition is Al-12%; Ni-28%; Co-5%; Fe-55%. It is especially well-suited to applications where operation is at a low flux density, due to short magnetic lengths and demagnetizing effects. Its mechanical strength is superior to that of the other grades. It is produced by both casting and sintering.

V Produces the greatest energy product of any commercially available magnetic material known (about 5.5 x 10^6 oersteds). The composition is Al-8%; Ni-14%; Co-24%; Cu-3%; Fe-51%. Maximum economy is obtained from this material when it is used at (or near) the peak energy product. Both cast and sintered magnets are available. Because it exhibits directional properties, magnetic design must be considered.

VI Is similar to Alnico V, with directional properties. It has a higher coercive force and a lower residual induction, and the peak energy is less (about 3.8 x 10^6 oersteds). The alloy consists of Al-8%; Ni-15%; Co-24%; Ti-1.25%; Cu-3%.

It is superior to Grade V when operated at a low flux density, due to short magnetic lengths or demagnetizing effects. It is also mechanically stronger than Grade V. Available as cast or sintered magnets.

VII Has the greatest coercive force of all the Alnicos. It does, however, have physical limitations because of its extreme brittleness. The composition is Al-8.5%; Ni-18.0%; Co-25.0%; Cu-3.25%; Ti-5.0%; Fe-40.25%.



Use of an Alnico V permanent magnet chuck on this milling machine made a 15% reduction in height possible.

Permanent magnets continued

a 0.200 in. diameter or less. The magnetic properties decrease with an increase in cross-section. Practical sizes range from 0.020 in. to 0.250 in. diameter. Rectangular magnets are limited to a maximum cross-sectional area of about 0.1 sq. in., a width of 0.625 in. and a minimum thickness of 0.040 in.

Cunife magnets have the advantage of not being brittle like most of the newer materials. The material can be swaged, drawn, rolled or punched and can be machined in the annealed or heat-treated state. It has a high tensile strength of about 100,000 psi for 0.050 in. diameter wire.

Cunife I has a peak energy product of 1.3×10^2 and a coercive force of 500 oersteds.

Cunico. Is an alloy containing approximately 50% copper, 21% nickel and 29% cobalt, with physical properties similar to Cunife.

It can be produced in wire or rods from 0.015 in. to 1.0 in. diameter. Magnets can also be produced by stamping from strips 1/64 in. to ⅛ in. thick and widths variable with the thickness.

Cunico has the advantages of being ductile and malleable. Even after final heat treatment, it can be swaged, drawn, rolled, machined or punched. In addition, it can be cast in certain finished forms. Cunico is not magnetically directional and greater flexibility of design is therefore possible.

Cunico has a peak energy product of 0.8×10^6 and a coercive force of 700 oersteds. However, because of the high nickel and cobalt content, the material is expensive for the energy produced and consequently is not widely used.

Silmanal. This, an alloy of silver, manganese and aluminum, is ductile, malleable and machinable. Its extremely low induction limits the use of the alloy to applications that require its exceptionally high intrinsic coercive force of 6,000 oersteds. This indicates that, for any demagnetizing force greater than 540 oersteds (the normal coercive force) but less than 6,000 oersteds, the direction of flux in the magnet reverses, but returns to its original direction when the demagnetizing force is removed.

The residual induction is only 540 gauss and the energy product is 75,000, less than 2% that of Alnico V.

Steel alloy magnets. This group includes chrome steel, tungsten and cobalt steel magnets. Magnets can be made by hot-forming bar stock and also (in the cobalt grades) by sand casting. The materials can be annealed for machining operations; chrome and tungsten magnets can be punched from thin annealed stock.

Chromium steel is a comparatively low-cost alloy adaptable to applications where weight and space are not too important and the energy requirements are not great. When 3.5% chromium is used, an energy product of 0.29×10^6 is obtained and the coercive force is 60 oersteds. Increasing the chromium content to 6% increases the coercive force to 65 oersteds at the expense of the energy product, which falls to 0.25×10^6.

Tungsten steel is physically and magnetically similar to chrome steel, but it is little used, because the greater cost is not justified by the increase in magnetic properties. An alloy with 6% tungsten has a peak energy product of 0.31×10^6 and a coercive force of 65 oersteds.

Before the introduction of Alnico, **cobalt steel** was the best permanent magnet material known. It is suitable for applications requiring (1) machine operations (since it can be annealed before final heat treatment) or (2), where the higher coercive force of Alnico is not required. The alloys of this group are relatively expensive for the energy output.

There are a number of grades. An alloy with 17% cobalt has a peak energy product of 0.65×10^6 and a coercive force of 150 oersteds. The grades with from 36 to 41% cobalt have a peak energy product of 0.9×10^6 for cast magnets and 0.98×10^6 for formed magnets. The coercive force is 240 oersteds in both cases. ★

This article on permanent magnet materials was written for Design Engineering by **Charles A. Maynard,** v-p engineering and research, the Indiana Steel Products Co.

Sample electrodes are loaded into the arc stand of the spectograph. Power source for discharge is at the right.

Science's chemical element detective

This instrument can detect the presence of over 60 of the elements

What does the spectrograph do?

A spectrograph is an instrument for identifying chemical elements (or for distinguishing between them) by recording a spectrum of lines on a photographic film. It can identify the constituents of a sample (both quantitatively and qualitatively) by separating the light given off by the sample in an electric arc into a spectrum of wavelengths (or colors).

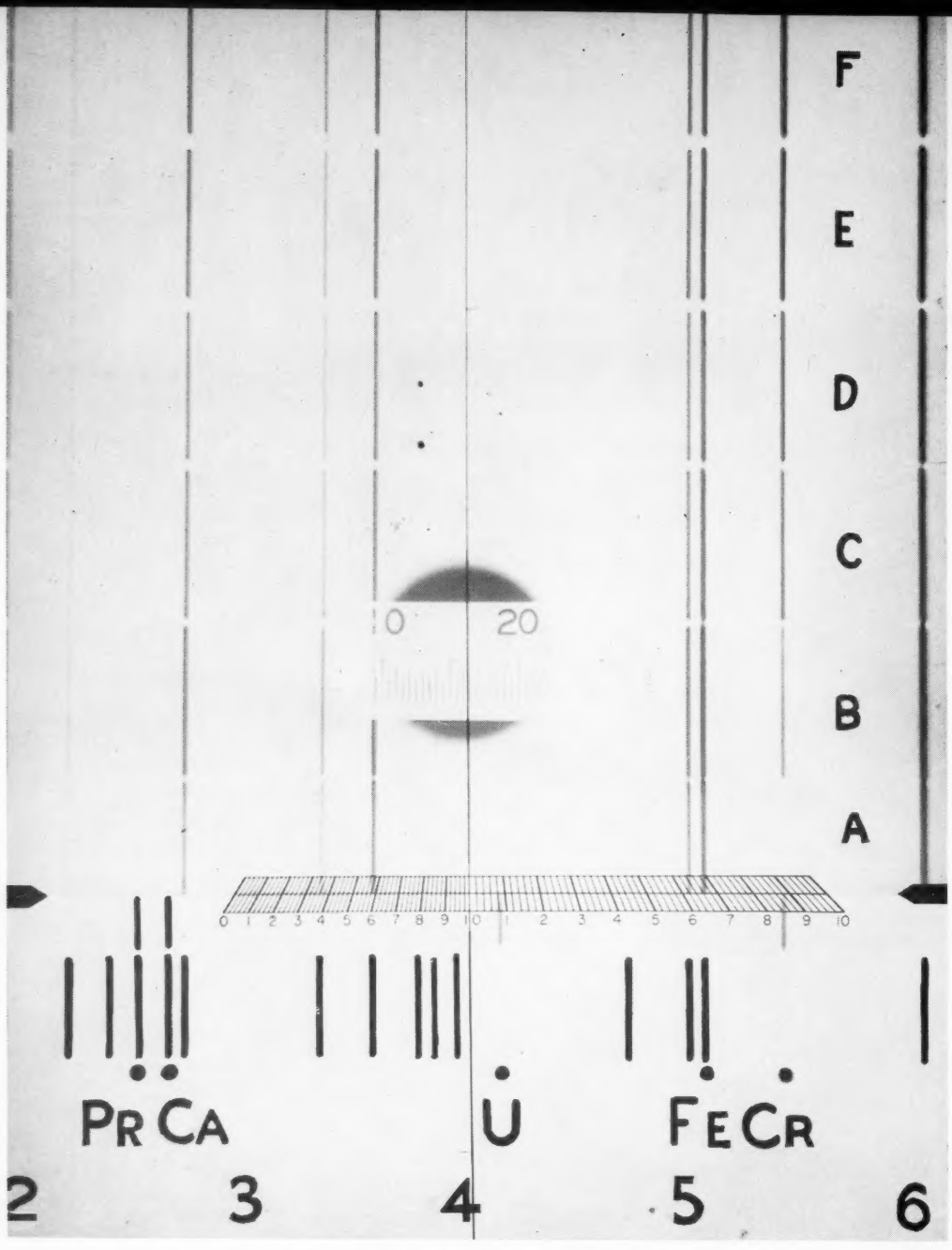
The instrument can thus detect the presence (or absence) of over 60 of the elements in almost any kind of sample, no matter whether it be in the form of drillings, cuttings, powder or liquid. For many of these elements it is sensitive to concentrations of 0.001% or less. Moreover, once the sample has been analyzed, a complete record of its chemical composition remains on film ready for inspection at any future date. Such performance makes the spectrograph an ideal analytical tool, both for the routine and the nonroutine laboratory.

By W. G. Linkert CANADIAN WESTINGHOUSE

The realization of rapid, economical control of chemical composition of materials has been a major factor in the vigorous industrial growth of the past two decades. Prior to the late 30s, analytical information was adequately supplied by a relatively small group of chemists and technicians using classical wet-chemical methods of analysis. Since 1939, however, there has developed such a remarkable demand for analytical service, that the chemist has been obliged to investigate newer and faster techniques.

Considerable attention has been given to the use of physical properties both for detecting the elements, and for determining their concentration. Research in this field has been so successful that, in certain cases, analysis has now become truly automatic. Ingeniously designed instruments (and intricate electronic circuits) have largely eliminated the need for tedious wet-chemical manipulation of the sample. As a result, the productivity of the analytical team has greatly increased and results which previously took hours (and sometimes days) to obtain, are now available in a matter of minutes. A typical example of the current trend toward instrumentation in analytical chemistry is the use of the emission spectrograph.

Based on principles of light expounded by Newton,



Here's how the densitometer screen looks

Photograph of the densitometer screen showing the spectra of steel samples A, B, C, D, E and F, whose chromium concentrations are respectively 0.04, 0.20, 0.35, 0.53, 0.96 and 1.72%. The vertical lines (immediately above the letters Cr) result from the excitation of chromium atoms in the spark discharge. Note the increasing blackness of the lines as the concentration of chromium in the samples increases. The lines above the letters Fe originate from the excitation of iron, the base metal in the steel. Since the concentration of this element is relatively constant throughout the series of samples, these lines do not show variation in blackness.

Two fields are in view on the screen; the portion above the arrows displays the spectra of the samples to be analyzed, whilst the portion below shows a master film calibrated for wavelength (Angstrom units). The dot above each chemical element symbol indicates where a line should appear in the spectrum if that element is present in the sample.

The accuracy with which the wavelength of the spectral lines can be estimated is increased by using the graduations between the arrows at either side of the screen. The blackness (or density) of the lines is read from the scale which appears in the spot in the upper portion of the screen.

Wollaston, Fraunhofer and others, the spectrograph has been devised to analyze the energy in the form of light that is emitted from a material burned in an electrical discharge. For it has been discovered that this energy is a fingerprint of the material being burned; it is a mixture of light rays, each of which is produced by a certain species of atom. All that is required (to identify the elements present in a sample) is to separate the light into its various components or wave lengths. The concentration of each element present is judged by the intensity of the light emitted at the various wavelengths.

Although several types of spectrograph are commercially available, there are four basic components common to each: a power source; two electrodes between which the sample is burned; a light dispersing medium, such as a quartz prism or a diffraction grating; and a means for recording the dispersed light or spectrum.

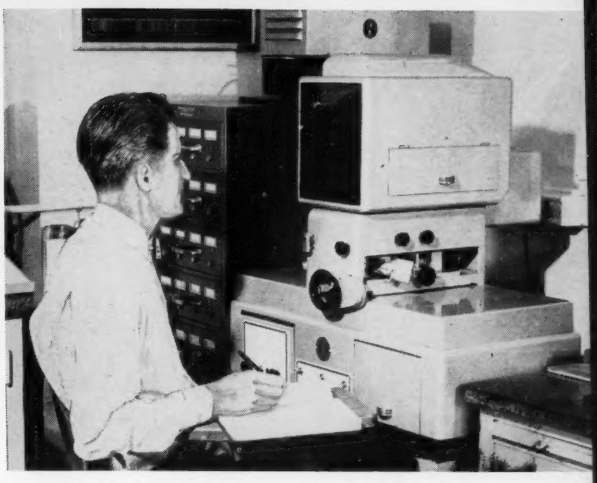
The power source of the spectrograph at the Research and Development Laboratories of the Canadian Westinghouse Company, Limited, can supply a variety of electrical discharges from a 15-amp d-c arc to a 20,000-volt spark. With such a variety of electrical conditions to choose from, it is possible to select the discharge that will produce optimum excitation of the sample, regardless of its chemical nature. This consideration is important when diverse materials are received for analysis. Special features (such as timers, remote control relays, safety switches and a cathode-ray oscilloscope display) permit the operator to control the dissipation of electrical energy in the discharge with maximum precision and safety.

The power supplied by the source unit is conducted to a pair of electrodes in an arc-spark stand resting upon an optical bench before the spectrograph proper. One of the electrodes in the discharge is usually a rod of pure graphite of about ¼-in. diameter. The form of the second electrode depends on the physical nature of the sample to be analyzed. If the specimen is a sufficiently large piece of metal, it may be fashioned into a pin similar in dimension to the graphite rod, or if it has a flat face, the discharge may be struck to its surface. In either case, the sample becomes a self-electrode. Should the material consist of drillings, chips or powder, it is packed into a cavity drilled in the end of a second graphite rod. If it is a liquid, it may be evaporated on the end of the rod. During the analysis, the energy dissipated between the two electrodes vaporizes the sample, causing it to emit its characteristic radiation.

Between the arc-spark stand and the spectrograph, a lens (and a filter system of metallized quartz plates) focuses the light from the discharge onto a narrow vertical slit. The slit is the entrance aperture to the spectrograph, which is simply a light-tight box on a frame holding (in fixed relationship) the slit, the light dispersing medium and a camera. Light passing through the slit is dispersed into its constituent wave lengths and reflected onto a special photographic emulsion.

In certain spectrographs, the dispersion of light into a spectrum is achieved by a quartz prism. The instrument described here, however, employs a diffraction grating for this purpose. Since the final results are similar, whichever system is used, their particular advantages and disadvantages will not be discussed in this article.

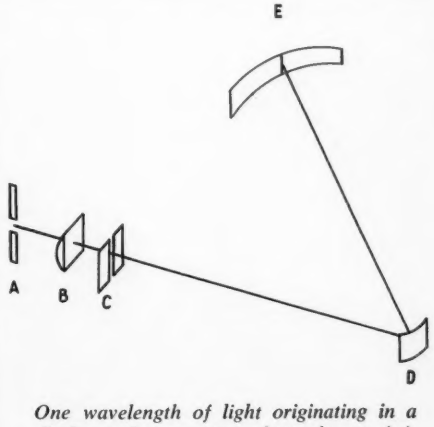
The diffraction grating is prepared by ruling on a concave, reflective surface, 90,000 parallel grooves over a space of 2½ in. The grooves must be straight and parallel within extremely small tolerances, and free from any periodic error. The task of ruling high quality gratings is so difficult, that an account of the design and operation of ruling machines or "engines" is a fascinating story in itself.



A projection-densitometer simplifies reading by projecting an enlarged image of the spectra on a screen.

Recording the spectrum on a photographic emulsion is the last step in a series of events that occur during the analysis. The emulsions used are specially prepared for sensitivity in the ultra-violet region of the electro-magnetic spectrum, where most of the useful analytical information is found. When the exposed film has been developed under rigidly controlled conditions of time and temperature, spectra appear as a series of fine lines, each an image of the slit through which the light entered the spectrograph.

To simplify reading, the film is placed in an instrument (called a projection-densitometer) which projects an enlarged image of the spectrum onto a viewing screen. Identification of the elements present in the sample is then made by comparing the unknown spectrum with a master film, calibrated to show the location (or wavelengths) of the more sensitive lines of the elements. **(Continued on page 82)**

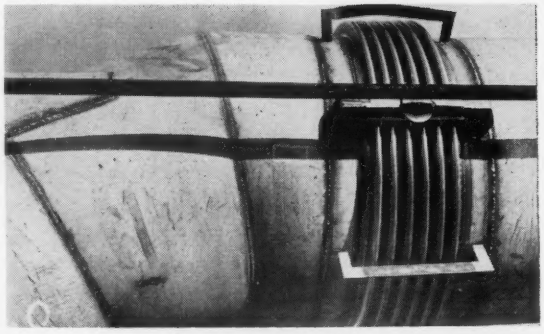


One wavelength of light originating in a discharge between two electrodes at A is traced through a lens B, a narrow slit C, to a diffraction grating D, where it is reflected onto a photographic film at E.

Design news in pictures

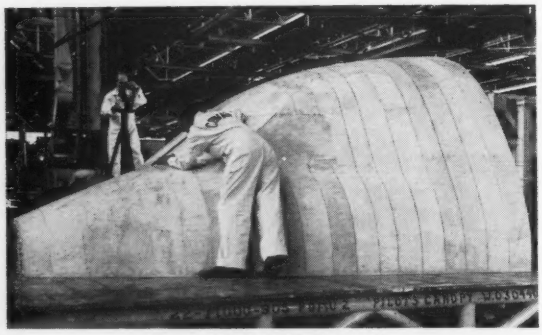
How not to do it

There are only two ways of lifting a load—the right and the wrong. Rather than demonstrate the wrong way and risk a strained back the safety engineer at Atomics International uses this model with a coilspring backbone set in wood. (200)



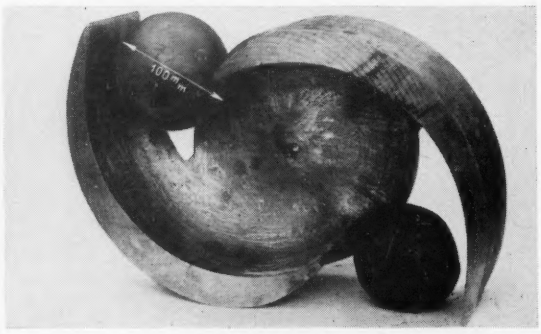
Jumbo expansion joint

This pipe handles air at 1,150 F and 35 psig. The bellows is a 48 in. stainless steel expansion joint and carries six corrugations. The unit is one of many in a butadiene and aviation gasoline plant recently completed in Texas. (201)



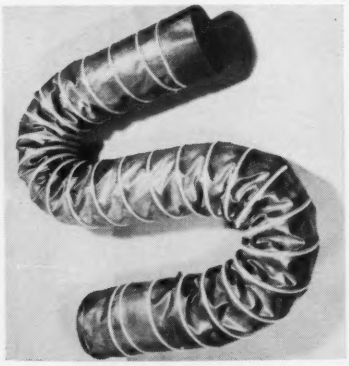
Here's where the driver sits

Production stretch press and forming dies for the nose section of the Convair 880 will be made from reference lines established on this full-scale plaster loft-line mockup. The shape of the canopy mockup is accurate to .005 in. (202)



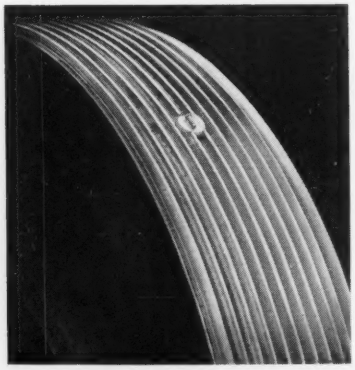
Reclining nude?

This refugee from an exhibition of modern sculpture turns out to be something much less glamorous. It's a part of a vertical waste-water pump and, more specifically, an open type impeller for unglamorous sewage. (203)



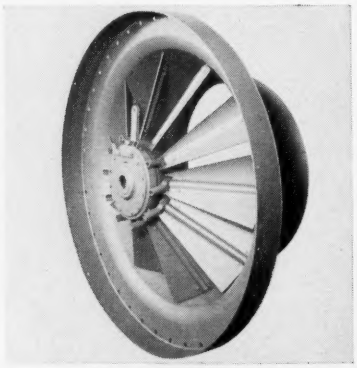
Supple as a snake

Known as Spiratube, this ducting is easily bent to 90 deg angles and U-bends with a minimum loss of air pressure. It has a thermoplastic scuffstrip. (204)



Thick and thin

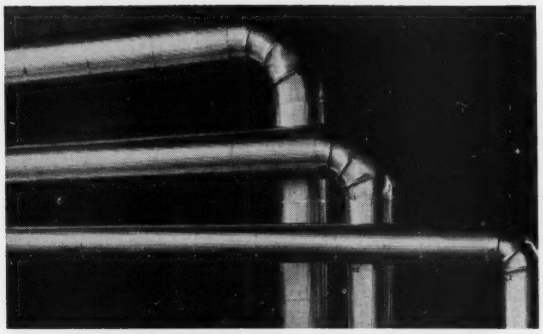
A wide range of fasteners can be made self-locking by the insertion of a nylon plug in the threaded area. Example: this tiny screw on a large plug. (205)



Variable pitch blades

Feature of this impeller is the vane control system. It enables a ready adjustment of the pitch of the blades and, consequently, of the air moved. (206)

Some modern designs making news today

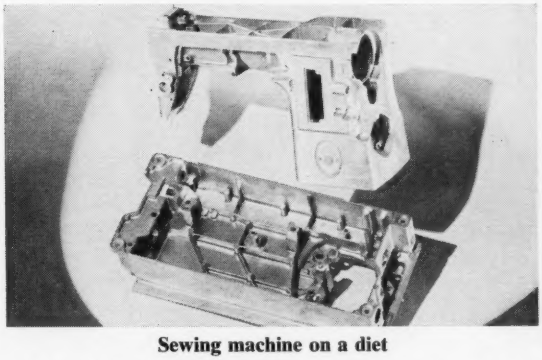


Protection at the elbow

Until recently there hasn't been a very good answer to the problem of protecting insulation on piping at the elbows. These jackets are deep-drawn from aluminum and are manufactured in both 90 and 45 degree ells in 23 sizes. (207)

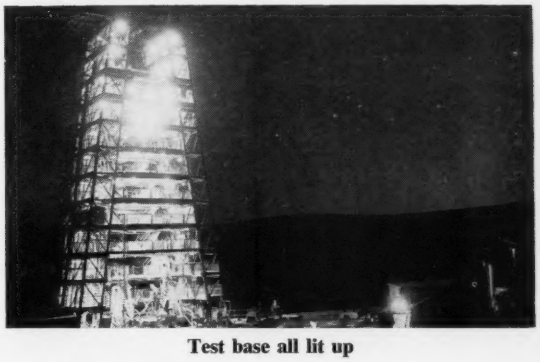
Radar for the surveyor

Distances from 500 ft. to 35 miles are easily measured with the Tellurometer. The device, which applies radar principles, has an accuracy finer than 1 part in 300,000 and requires only two men in operation, one at each station. (208)



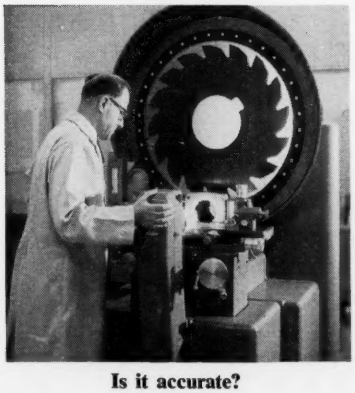
Sewing machine on a diet

Use of aluminum die castings in the manufacture of sewing machines has effected substantial savings in machining and finishing operations. Intricate castings are turned out easily at high production rates with cast-in lugs and cored holes. (209)



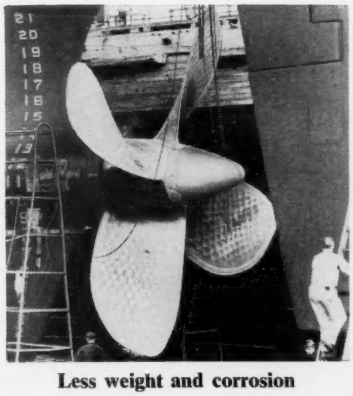
Test base all lit up

First photos of the Atlas missile tower to be released show it as a brightly lit fairground attraction thrusting into the California night sky. The San Diego base is one of three where the USAF's Atlas is under test by Convair. (210)



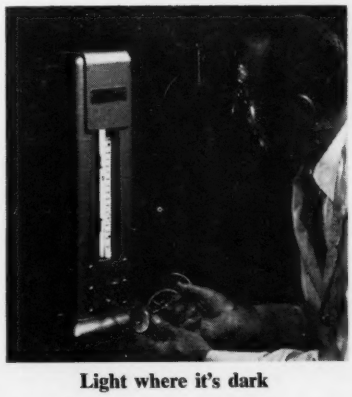
Is it accurate?

A new standards laboratory has been opened in Clifton, N.J. This machine, one of many, is carrying out a certified standard test on a master gear. (211)



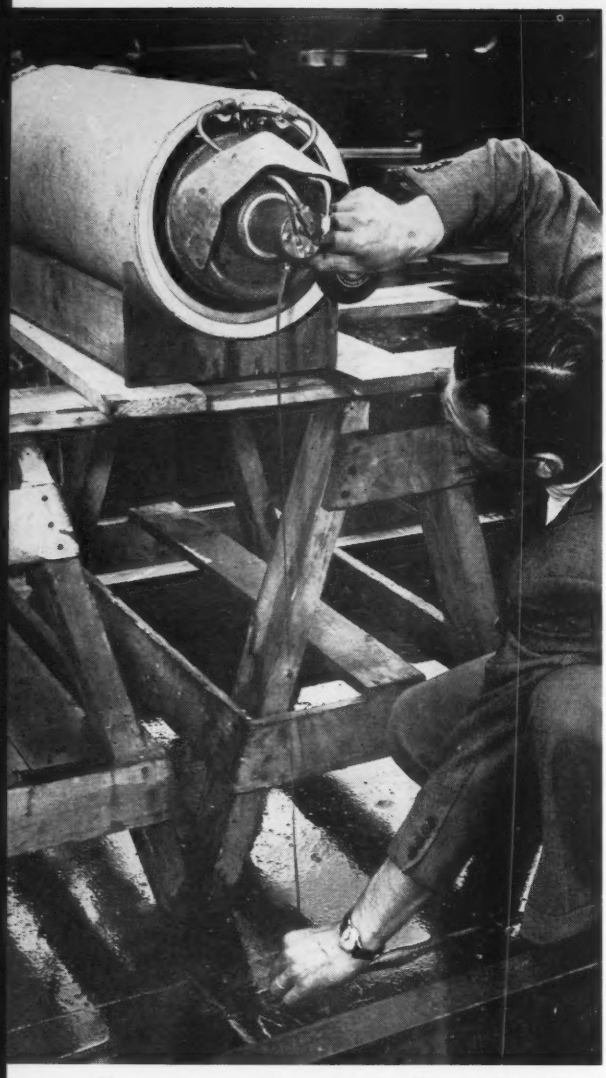
Less weight and corrosion

The latest ship of the American President Lines has a screw made of nialite, a zinc-free alloy lighter and stronger than the usual manganese bronze. (212)



Light where it's dark

The manufacturer of this air gauge is providing a new series of illuminated models for places where the position of the column makes readings hard. (213)



X-ray unit carefully positioned before inspection of welds on the Honorable George Dunbar Bridge, Ottawa.

An increasingly useful technique

X-ray testing has recently spread its wings. Formerly regarded as a cumbersome, static sort of tool (reserved exclusively for flaw detection in highly developed industrial plants and laboratories) it is now extensively used far out in the field, away from power supplies and other industrial facilities. It is employed in such widely diversified applications as bridge building and electronics manufacture; in the laying of gas and oil pipelines and in aircraft maintenance. No longer is it merely a device for detecting flaws; it has become a production tool that is used more and more to check close tolerances in intricate assemblies.

X-ray testing spreads

A onetime heavyweight technique without

E. Peter Hersey V-P THE WARNOCH HERSEY CO. LTD.

Before considering the "New Look" in X-ray techniques, it might perhaps be as well to review very briefly the evolution of X-ray testing in industry. As every schoolboy knows, X-rays were being used in medicine almost from the time that Roentgen first invented the technique in 1895. Industrial use, however, came much later, being at first confined chiefly to such obvious applications as the detection of flaws in castings. World War I saw its first period of rapid growth and World War II gave it further impetus. Rapid advances have been made during the last few years because of the increasing complexity of manufacturing methods and the greater emphasis on waste elimination.

One important industrial use of X-rays in Canada during the past two or three decades is in the field of platework fabrication. The change-over from riveted to welded boilers, refinery towers, pulp digesters and the like started in the early thirties. Even during the last war, boilers were still being riveted in some cases, but toward the end, welding had completely taken over.

With the advent of welding came stress-relieving techniques and many highly developed tests and checks in addition to X-rays. However, this method of testing is still the principal method of ensuring the soundness of welds. It has, of course, the great advantage of providing permanent records.

Newer trends: In spite of the great strides in X-ray techniques achieved by the forties, its use was still quite limited in certain directions. One of the troubles was that the machines were usually so large and cumbersome that they could only be used in industrial plants where efficient handling facilities existed. Moreover, they depended on the availability of electricity supplies. During the war years, attention began to be given to the use of gamma rays as a portable source of radioactivity for projects far from industrial plants and power sources. But though gamma rays have their own useful applications, it was found in practice that they did not provide nearly the same definition as X-rays, especially in the case of small sections.

Two spurs to inventiveness arrived simultaneously during World War II; the universal change-over from riveted to welded ship construction and the enormous growth of the aircraft industry. These happenings hastened the development of small X-ray machines that could conveniently be brought to the job, not vice-versa.

wide its new wings

mobility, X-ray testing is now a versatile production tool for industry

Among the first to tackle this problem seriously (and to arrive at a satisfactory solution) was the firm of Triplett and Barton of Burbank, California, who produced a revolutionary machine weighing only a fraction of the older models.

Yet the surprising thing is that though the weight was cut down so drastically in the new machines, the quality of the results was actually improved. For example, they provided sharper definition, due to the smaller focus size of the tube. Also, the tube head (weighing only 65 lb.) was designed to provide 360 deg. radiation. This meant a considerable time-saving in taking X-ray pictures of circumferential welds.

The new machine was no weakling when it came to power, for it was designed to be used continuously, from 50 kvp to 257 kvp and would deliver 10 ma even at top voltage. Hence, it could be used efficiently to check for defects in steel up to 4½ in. thick and to even greater depths in non-ferrous metals.

Aiding the technical advances in the X-ray machines came great improvements in the quality of the film. Many types of film are now available for various purposes, depending on the material to be inspected, its size, shape, weight and location. There are special ones for different types of radiation, for critical examination of detail and for over-all inspection. Indeed, the photographic companies deserve a full share of praise for the new developments.

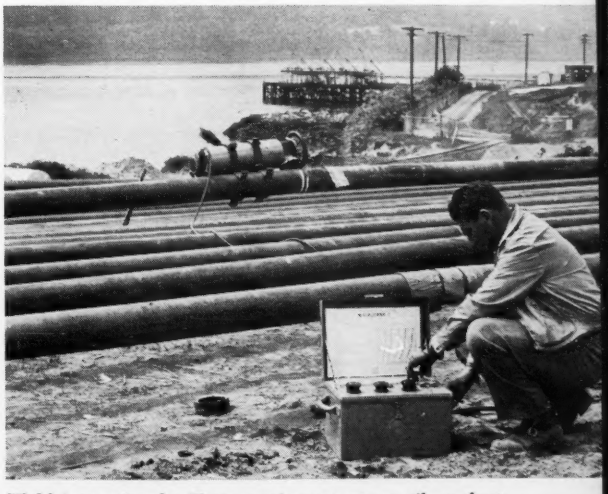
Applications: It has been mentioned that the aircraft industry was one of the prime movers in the development of the new techniques. Manufacturers had been toying for years with the idea of using X-rays, not only for testing individual components, but also for measuring tolerances in complicated assemblies that were inaccessible by any other means. The new techniques now available made this possible and X-rays began to be used at many stages of fabrication and assembly. From the manufacturing shops their use spread to the service and maintenance hangers. It now became possible to "see right through" a wing section, a landing gear, strut or other item of prime importance to check the assembly after completion, or to investigate any possible weakening or damage which might have been the result of service conditions. From the field of military aircraft and guided missiles, its use spread to the commercial airlines, where it is now becoming a recognized technique for increasing safety and saving thousands of man-hours in maintenance.

In the marine field, the use of these portable X-ray units gradually extended throughout industry and includes some dramatic special applications such as the U.S.S. Nautilus, the world's first atomic submarine. Nearer home, the Canadian Government hydrographic survey boat (S.S. Baffin, completed last year and now in service) saw considerable use of the new machines.

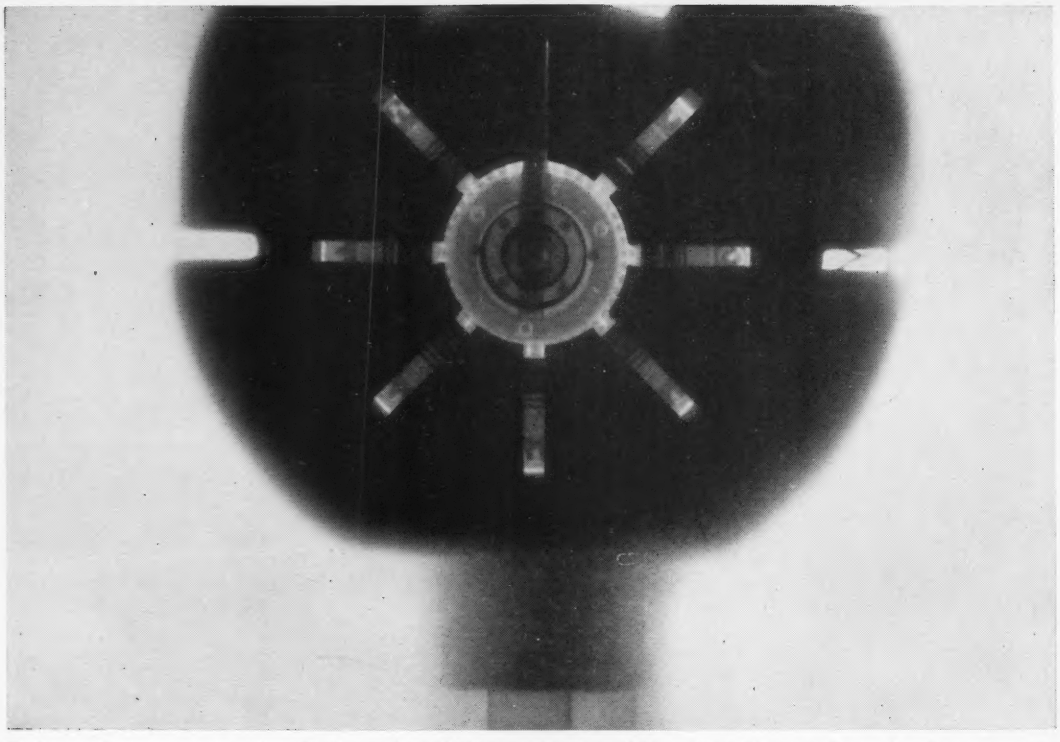
Original specifications for the fabrication of this vessel called for drilled plugs. The use of non-destructive methods eliminated the need for these plugs and provided a much more reliable testing procedure.

In this application, 20% of the welded seams joining the hull plates throughout the ship were examined by X-rays, films being taken in a definite pattern. Special attention was given to highly stressed areas and most of the films covered places where several plates came together.

Special problems were posed by junctions of plates of widely different thickness; they made the choice of



Weld inspection by X-ray equipment on an oil products pipeline. Client was Imperial Oil: place, Ioco, B. C.



Radar equipment power valve. Radiograph enabled examination without disturbing totally-enclosed components.

"Much praise for X-ray development goes to photographic companies"

appropriate exposures and films more complicated.

Heavy industry: Within the last few years, there has been considerable growth in Canada in the use of welding for structural steel buildings. Even so, there are many consulting engineers who still have misgivings about the vital field-welded tension joints, the strength of which depends so greatly upon the skill of the individual welder. Utrasonic testing has played an important part in this field but does not, of course, provide a permanent record. Portable X-ray machines (of the type described) have recently been used in a Toronto building to test butt-welds in the main columns; it has also been used in connection with the fabrication of a welded bridge in Ottawa. In the latter case, however, the portable X-ray techniques were applied in the fabricating shop, which, as it happened, did not possess its own X-ray equipment. This example emphasizes a subsidiary advantage of the new machines; they have made it possible for smaller shops to carry out high-class welded work, which was formerly the prerogative of the larger and more fully integrated companies.

Other excellent applications of portable machines occur in the fields of power generation and in the oil and gas industries. Penstocks, scroll cases, draft tubes and high-pressure steam lines are now being regularly checked by X-rays, thereby removing any element of doubt from the welding of these critical items. In the construction of oil and gas pipelines, X-ray technicians follow right behind the welders and develop their plates in portable dark-rooms.

Two special jobs: X-rays, like any other testing method, cannot provide all the answers and they are often used in conjunction with other methods. An interesting example arose recently in the manufacture of a large welded tank to be used for the manufacture of nitro-glycerine. Inspection procedure called for the most meticulous X-ray inspection of all welds, but to make doubly sure, further tests of the inside surfaces were made by zyglo fluorescent penetrant to show up any depressions, crypts or incipient cracks likely to cause trouble later.

Another special case arose within recent months in the manufacture of welded pressure vessels (fabricated of alloy steel) for duty at extremely high pressures and temperatures. The specification for these vessels called for X-ray testing, followed by ultrasonic testing, dye penetrant, hydrostatic tests at double the working pressure and finally by a helium gas test!

Electronics: In this field, the new X-ray machines are being employed to check the internal structure of electronic tubes after assembly. They can determine tolerances between components to an accuracy of 0.0003 in., verify alignment, help to detect poor fabrication and compare similar assemblies in production. ★

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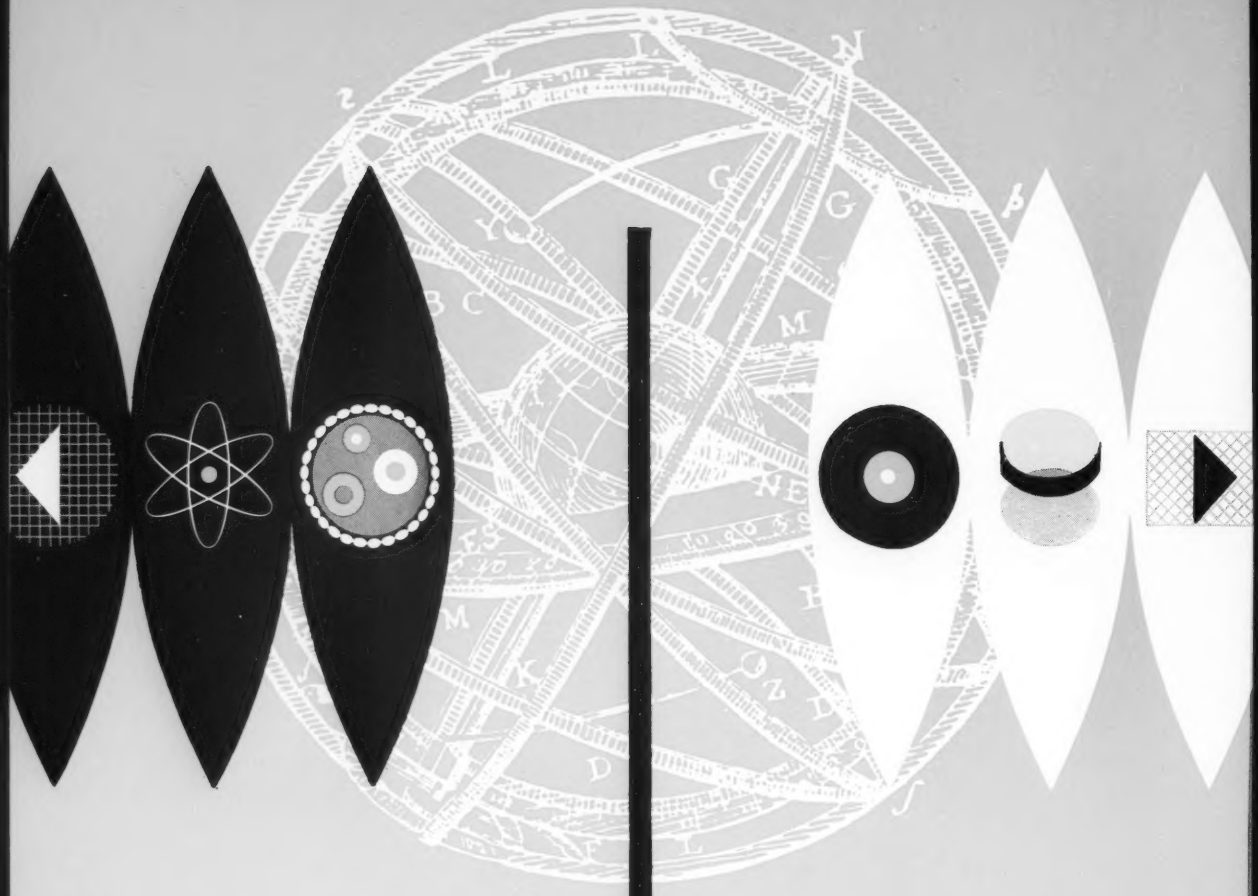

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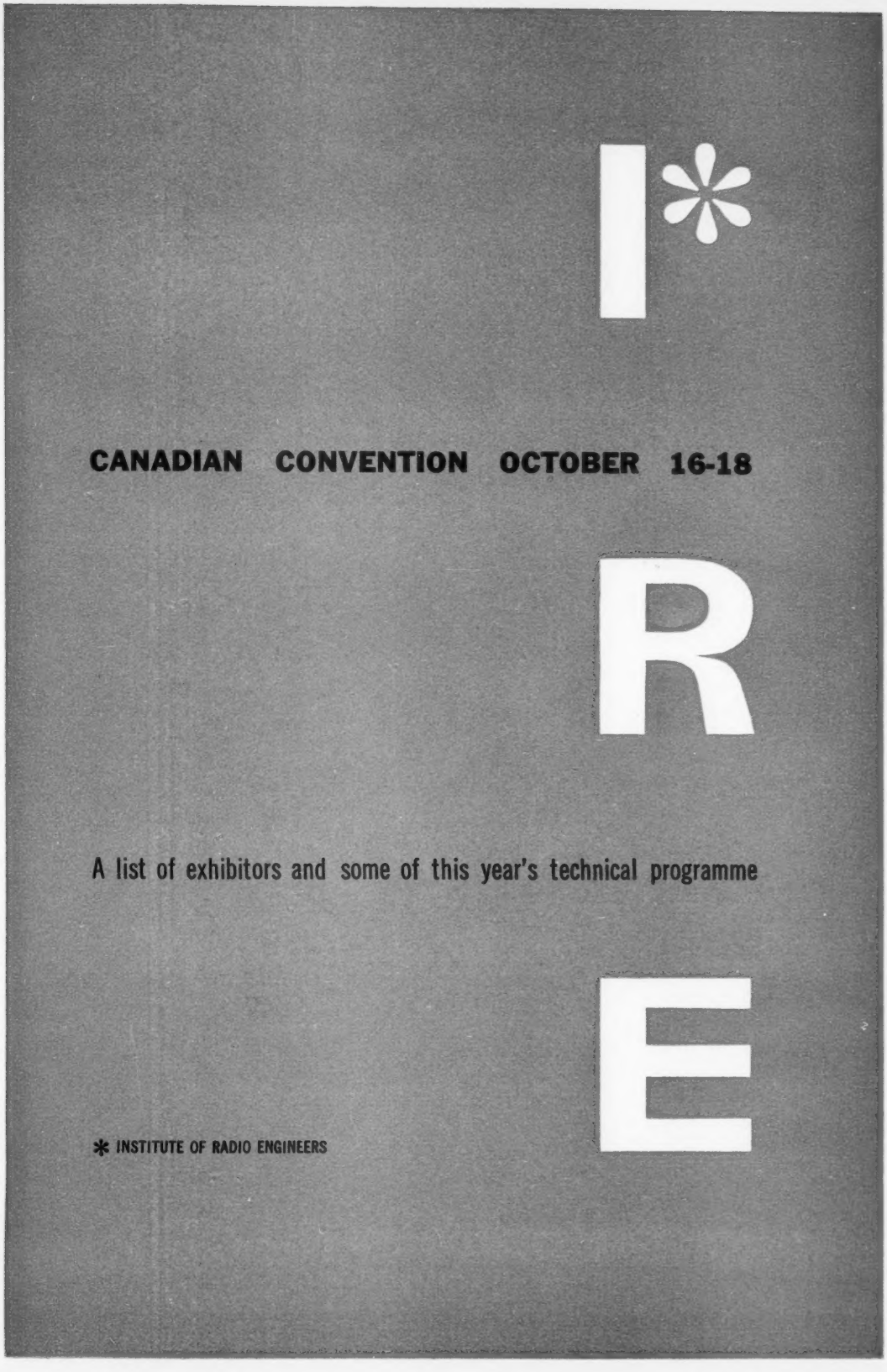
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CANADIAN CONVENTION OCTOBER 16-18
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* INSTITUTE OF RADIO ENGINEERS

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Frank Noakes, Head of the Dept. of Electrical Engineering, University of British Columbia, Vancouver, B.C.
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Aeromotive Engineering Products
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Aircraft Appliances & Equipment Limited
Aircraft-Marine Products of Canada Ltd.
American Electrical Heater Company
Alford Manufacturing Company, Inc.
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General Radio Company
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Honeywell Controls Limited
Samuel C. Hooker (Canada) Limited
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I

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The Institute of Radio Engineers
Instronics Limited
International Electronic Research Corporation
The International Nickel Co. of Canada Ltd.
International Resistance Co. Ltd.

K

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Kester Solder Company of Canada Ltd.

L

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Leonard Electric Limited
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M

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T

Tecneek Associates
Tektronix Incorporated
The Telegraph Condenser Co. (Canada) Ltd.
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U

University of Toronto, Department of Electrical Engineering

V

Varian Associates of Canada Limited

W

A. C. Wickman Limited
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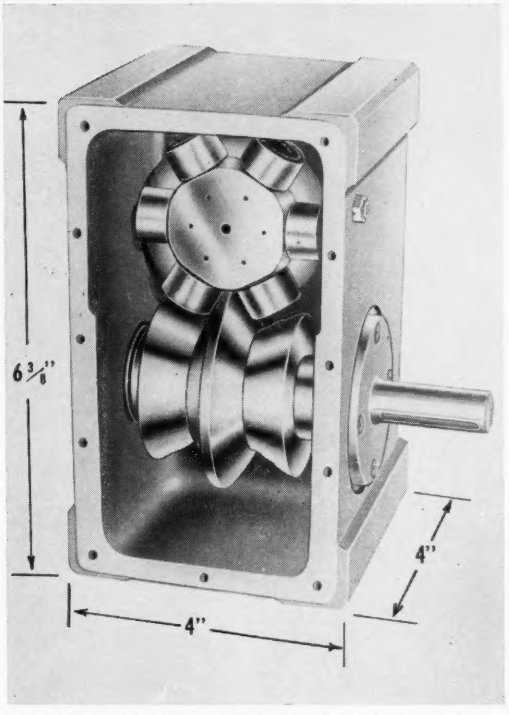
Ideas round-up

Roller gear drive: smaller and faster



Cartridge method of mounting hub speeds assembly and adjustment and permits free access to the components.

A series of smaller, faster roller gear drives for high speed, precision indexing have been developed by **The Ferguson Machine Corporation** to supplement their line of standard cam indexing mechanisms. The new E series, rated for 2,000 indexes a minute, are specially designed for the instrumentation, packaging, photographic and pharmaceutical fields and other industries with applications for higher indexing speeds and lower torque requirements than those provided for in the regular line.

Components of the mechanism consist of a precision cut, hardened tool steel cam with a tapered rib and hub with standard bearing followers. Two followers are in contact with the cam rib at all times. As the cam rotates, a curved portion of the rib indexes the hub and output shaft. When the followers reach a straight section of the rib, "dwell" occurs and the hub is locked with a precision of 0.001 in. and zero backlash without auxiliary locking or locating methods. The units are rated for a minimum of 8,000-hr precison operation and employ a modified trapezoidal acceleration characteristic for smooth, vibration-free indexing.

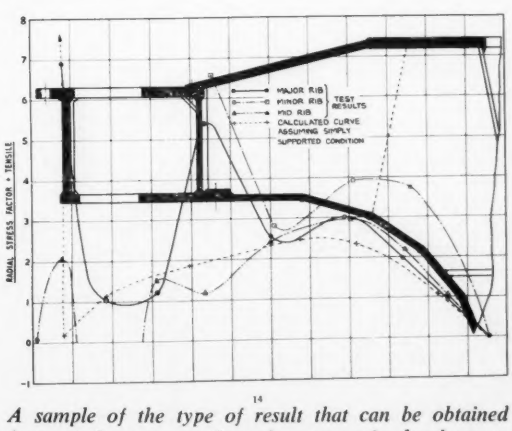
The standard E series drives are available from stock with 3, 4, 6, 8 and 12 stops and with indexing periods of 120, 180 and 270 deg. Housings for the new models are as small as 6⅜x4x4 in. Ferguson will also provide special units and oscillating drives in the smaller sizes using standard components whenever possible.

Illustrated is a six-stop unit in a stock MH-1 housing. New "cartridge" method of mounting hub speeds assembly and adjustment and permits free access to components when housing cover is removed.

Water turbines: information from models

Faced with the difficulties of accurate stress calculation when designing some of the more complex fabricated components of water turbines, **English Electric** have found during recent years that very useful information can be derived from the stress analysis (by strain gauge methods) of precisely scaled models of welded steel plate structures. Strain gauge testing of full size components, either in operation or hydrostatic pressure test, has in the past provided useful stress data, but too often difficulties and doubts arise from the care necessary in placing the strain gauges on the stressed component. This work is better suited to true laboratory conditions, and by doing this with scale models of approximately one-sixth full size, a thoroughly reliable means of obtaining stress and deflection data has resulted. An additional advantage, of course, is that a far wider variation of designs can be tested before coming to a final conclusion and before manufacture begins.

The structural models used for strain gauge analysis



A sample of the type of result that can be obtained from strain gauge testing of a composite head cover.

are true to scale in all general dimensions and have plate thicknesses correct to within 7 or 10%. The model plate thickness is chosen to the closest available standard size.

The limit to the scale of the model is detremined mainly by the smallest size of weld that can be produced to the correct form.

It is not possible, for instance, to make welds smaller than 1/16 in. For general structural minimum sized welds of ¼ in. to ⅜ in. this gives a minimum scale factor of 1 to 6. With extremely large and heavy plate components, scale factors may be increased to a value of 1 to 10.

The stresses induced in the model due to the external loads applied on test are equal to those on the prototype structure. The deflection on the other hand are, of course, proportional to the scale factor. That is, the prototype deflections are approximately six times those measured during model testing.

A sample of the type of result obtained from model tests is shown, together with the calculated curve for a simply-supported condition of a simplified equivalent flat plate of varying section. In addition to model tests on structures of fairly conventional design, the same technique assists in the development of new forms of structure.

Slide charts: a big squeeze on facts

A slide chart is a simple device, precision manufactured from paper or plastic, that puts product facts at the fingertips of users, prospects and salesmen. In one move of a slide or turn of a disc, a properly made slide chart can select equipment, solve mathematical or engineering problems or tell a sales story graphically.

Designed primarily as a sales aid, slide charts are of interest to the design engineer inasmuch as he often receives them as an aid to specifying (and as a reminder of the good qualities of) the product of the manufacturer who gives them.

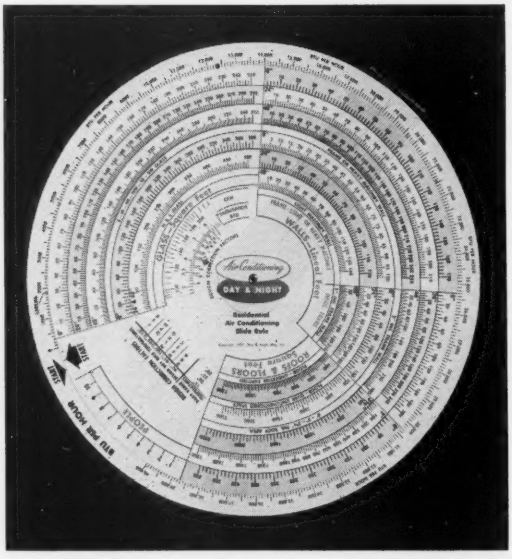
Like the slide rule, a slide chart is intended to get the maximum number of facts into the minimum space and, at the same time, make them quickly available.

Slide chart designing is a job for experts. To be most effective, it must be easy to use and instructions must boil down to a few direct commands printed on the face. Operations must reduce to one or two simple movements and printing and aligning of the cards that slide or rotate must be accurate.

A leader in this field is the **Perrygraf Corp.** They originated the slide chart and have produced more than 16,000 different designs.

An example of the length to which this "fact-squeezing" can be taken is provided by the manufacturer who had an idea for 15 different wheels to cope with 15 calculating operations. Perrygraf managed to reduce the whole thing to a two-wheel vest-pocket slide chart and, as a very worthwhile bonus, reduced the cost from $2.50 to 22c.

A sampler (known as the "Idea Starter Kit") is available; it shows the wide range of slide charts that can be made. The kit includes charts with such diverse applications as a duct-sizing calculator, a rate finder, a dynamic energy chart, a frequency calculator, an antenna calculator, a gas flow computer and a milling setup calculator.



A sample slide chart for the air-conditioning industry.

Also available (alas, not included in the kit) is a "Poker Pal." This essential aid to the riverboat engineer will tell him what kind of a hand he needs to win, based on the game, number of players and wild cards. It also gives him the odds of making a winning hand, based on what he holds at every stage of the game.

Propane carburetor: a means of using a modern fuel

Designed and manufactured in Canada by **Delamere & Williams Co. Ltd.,** the Le Clair propane carburetor offers all the advantages of this modern fuel (now readily available here) for fork lift trucks and other units powered by gasoline engines.

Supplied in two component parts, the carburetor can be mounted easily and effectively on all existing engines; it is approved by the Underwriters Laboratories of Canada.

The use of propane gas is claimed to give more nearly perfect combustion and more even fuel distribution, and so greater economy. Engine efficiency can be increased to take advantage of the high octane rating of propane, which is 120 as against 90 for premium gaso-

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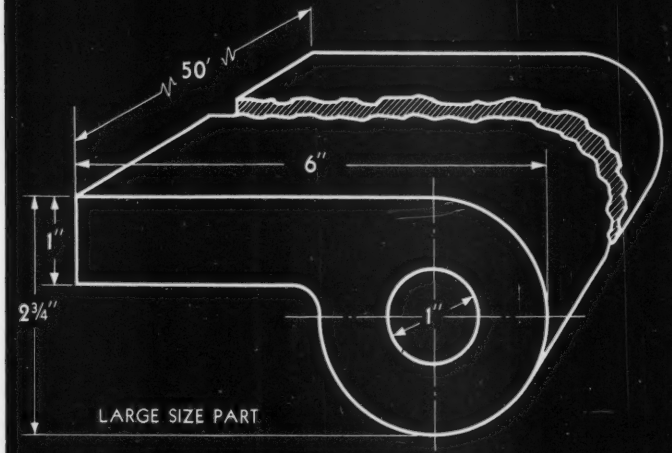
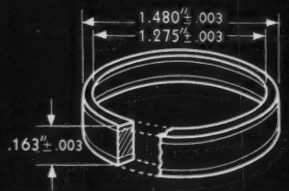
Engineered and Precision Moulded Products

Dominion Rubber's engineers will work with your designers to solve your production problems

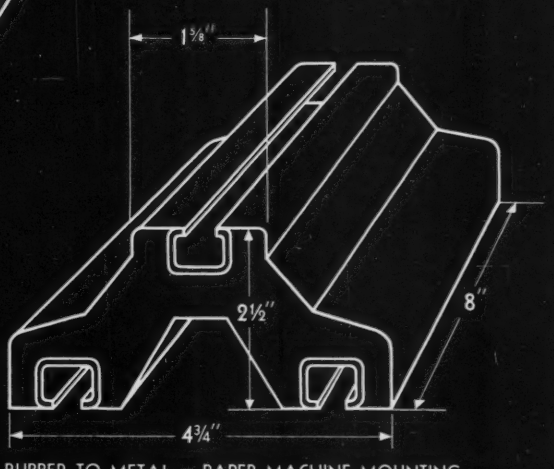


LARGE SIZE PART

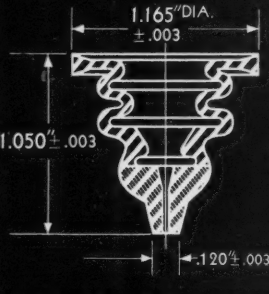
ST. LAWRENCE SEAWAY GATE SEAL



WATER PROOFING RING — RUBBER TO METAL
PRECISION PARTS FOR
INDUSTRY AND ARMED FORCES



RUBBER TO METAL — PAPER MACHINE MOUNTING



SMALL INTRICATE CLOSE TOLERANCES PART
COMBINATION OF TWO TYPES OF RUBBER USED

Dominion molding experts have the "know how" and the facilities to engineer molded products to meet your most rigid specifications — from the smallest of precision parts to complete products of *any* size.

Dominion Rubber expertly molds engineered rubber and plastic parts to suit your service requirements and provide the right balance of properties, such as tensile strength, resiliency, resistance to acids, solvents and other chemicals. And Dominion Rubber makes them to perform most efficiently over a broad range of temperatures.

Another Product of Progress for Canada's Growing Industries

RUBBER COMPARATOR

TYPE OF RUBBER	Specific Gravity	TENSILE: Very Low PSI	TENSILE: High PSI	Tear Resistance	Abrasion Resistance	Ageing (Light)	Ageing (Heat)	Resilience	Heat (Short)	Heat (Long)	Resistance to Flex-Cracking	Resistance to Compression Set	Resistance to Permanent Set	Resistance to Ozone	Oil and Gasoline Resistance	Acid Resistance	Water Resistance	Cold Resistance	Electrical Insulation	Permeability to Gases
G. R. S.	0.94	400	3500	P to F	E	P	G	E	G	P to F	G	F	P	P to F	G	P	F to G	M		
Natural Rubber	0.93	3000	4500	G	E	P	G	F	F	G	G	G	P	P	E	P	E	M		
Buna-N	1.00	600	3500	F	G	P	F	G	G	F	G	G	G	E	G	E	G	P	L	
Neoprene	1.25	3500	3000	F to G	E	VG	G	G	G	G	G	G	F	F to G	G	E	G	P	L	
Thiokol	1.35	300	1500	F	P	G	G	P	G	P	P	P	P	P	E	P	P	VP	VL	
Butyl	0.91	3000	3000	G	F	F	G	VG	G	G	VG	P	P	P	E	P	G	EL		
Silicone	1.25	800	1000	F to G	P	E	E	E	G	F to G	E	G to E	P	P to F	F to G	E	E	M		

IMPORTANT NOTE.—These are general properties. Within any one group, modifications can be made by compounding techniques.

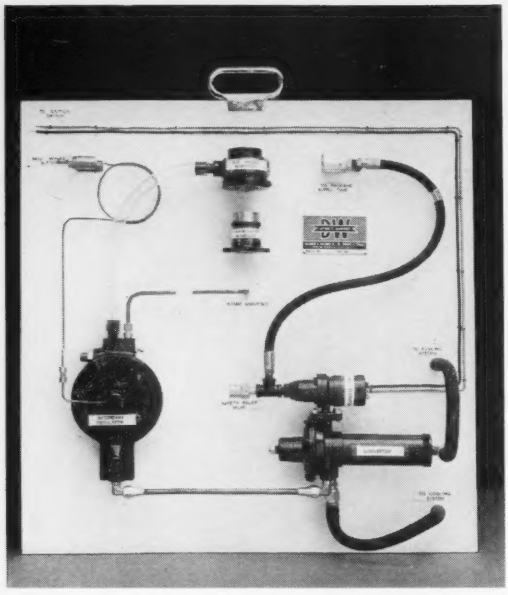
*Except Aromatics — Poor

E—Excellent, G—Good, F—Fair, VG—Very Good, M—Medium, VL—Very Low, EL—Extra Low, L—Low, P—Poor

DOMINION RUBBER

Dominion Rubber

Mechanical Goods Division



Demonstration layout of Le Clair's propane carburetor.

line. Because the fuel enters the engine as a gas (and not as a liquid), there is more complete combustion and much easier starting in the coldest weather.

Propane produces virtually no carbon, gums, acid or lead deposits, so that engine overhaul is not required so often and spark plug life is increased. Because propane enters the engine as a dry gas, there is no dilution of the oil in the crank case, and oil changes are therefore less frequent.

The accurately controlled air-fuel mixture supplied by the Le Clair carburetor burns to carbon dioxide and water vapour (with only a trace of carbon monoxide) and obnoxious fumes and smoke are entirely absent. Engines fitted with this equipment may be operated indoors without discomfort or harmful effect to employees.

Fuel is stored under pressure so that there is no spillage, no flooding during cold starting and no evaporation losses. Fire risk is less than with gasoline.

Once adjusted, the Le Clair equipment is claimed to keep in tune indefinitely, due to its simple but robust design.

The secondary regulator has an automatic lock-off feature that prevents the release of gas when the engine is not running. In the event of an excessive pressure rise, a solenoid valve connected to the ignition switch cuts off the supply of propane whenever the switch is off.

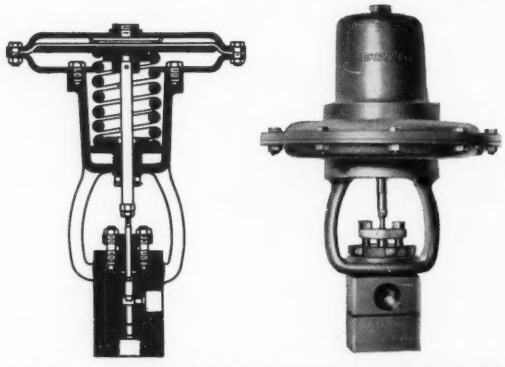
Pneumatic valve: gases up to 10,000 psi

Just introduced by Honeywell's Valve Division is a new line of fast-acting, pneumatically operated industrial valves.

The new line (known as Series 200) is available in two models: one is a piston-operated throttling valve and the other a diaphragm-operated two-position valve. Both are designed to handle gases (such as air, helium, nitrogen and argon) at pressures up to 10,000 psi. The valves allow pressure drops as high as 6,000 psi under flowing conditions. They work at temperatures from —40F to +400F. An even wider temperature range is possible in special versions.

The throttling valve is 15⅜ in. x 13 5/32 in. and the two-position valve, 10½ in. x 11⅝ in. They have split-body construction of stainless steel with clamped-in seat ring.

Both types are available as hand-operated models with the same body construction.



Naked and clothed views of two models of Honeywell's fast-acting, pneumatically-operated industrial valves.

Air-cleaner: a plastic oil-soaked sponge

An air cleaner featuring simplified design and a plastic filter element has been developed by **Power Products Corporation.**

The new cleaner can be used on many products that require air filtering and will be marketed to other firms. The company will put it on the engines it makes for nearly 40 power mower manufacturers.

Key to the new unit is the filter element, made of polyurethane foam, treated by a special process for which patents have been applied. The resulting filter is a soft, sponge-like element that allows free flow of air through it. The plastic can be cut to any suitable size or shape. Before use, it is impregnated with oil containing an additive that allows easy cleaning.

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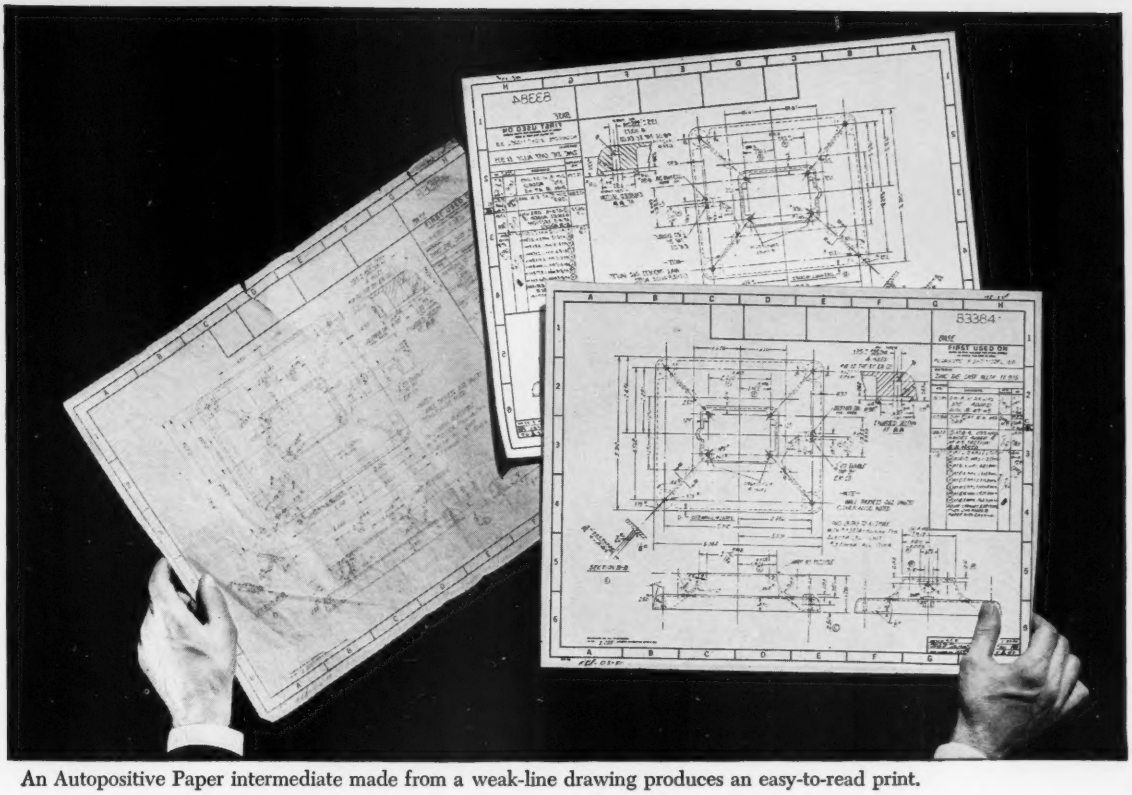

An Autopositive Paper intermediate made from a weak-line drawing produces an easy-to-read print.

Tonic for Tired Tracings

SOME OF THE TRACINGS your customers send in were probably "tired" from the start—have light, anemic lines incapable of turning out really readable prints. Others owe their lack of graphite to constant handling and use in print making.

To produce legible prints from such lacklustre originals is easier than it looks. Simply reproduce them on Kodagraph Autopositive Paper or Film, depending on their condition. It's amazing how these materials can step up line density . . . render even faint detail crisply and sharply.

Let your customers know soon what you can do for their tired tracings. They'll waste a lot of time and money if they think retracing is the only way out.

CANADIAN KODAK CO., LIMITED
Toronto 9, Ontario

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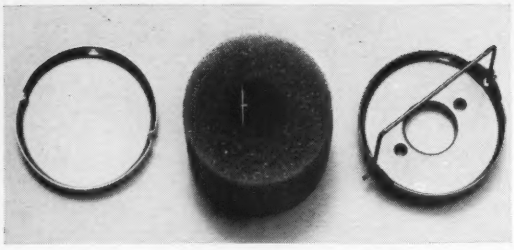


No tools are needed to strip down this air cleaner.

The treated plastic offers these advantages:
(1) It is partially self-cleaning, for slight vibration of the element causes large pieces of foreign matter to fall off.
(2) The filter has a "built-in warning system." As it becomes clogged, its amplitude of vibration increases, indicating to the operator that the cleaner needs washing.
(3) No tools are needed for taking down the filter assembly.
(4) The element can be cleaned by washing in water.
(5) It can stand rough treatment because of its resilience.
(6) The resilience also assures a tight seal between the filter and the base and cap of the cleaner.
(7) The cleaner can be operated at any angle, because no oil reservoir is employed.
(8) It is not affected by the temperature of normal engine operation nor by gasoline or oil.

Water meter: an essay in simplification

A new type of water meter, using magnetic force to transmit motion from the measuring chamber to a hermetically sealed register, is announced by **Rockwell Manufacturing Company.**

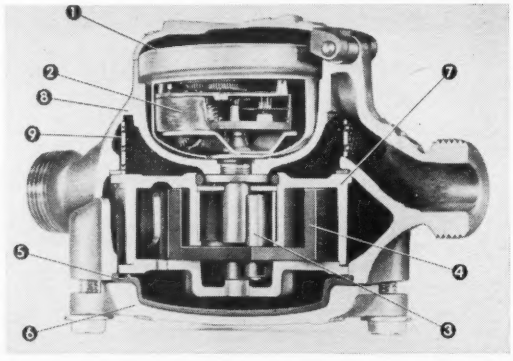
This sealed register water meter differs radically in design and construction from existing devices. Its announcement climaxes a 12-year research and development program.

In contrast to conventional water meters, the meter contains no stuffing box or separate intermediate gear train. The entire unit contains 15 stock parts, of which only 2 operate in contact with water. (Conventional water meters have from 50 to 85 parts, with no less than nine operating within the water.)

Replacing the separate gear train and stuffing box in the new meter are two permanent magnets. One magnet is contained in the oscillating piston in the measuring chamber; the other travels in a well in the sealed register. The force between them effectively transmits motion from measuring chamber to register.

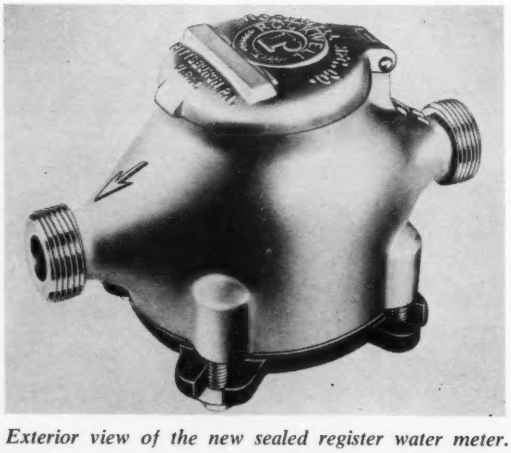
In conventional meters, both open and enclosed intermediate gear trains operate in water and are subject to corrosion and wear, Rockwell engineers pointed out. The gearing is necessarily heavy to assure a reasonable life span. Heavy gearing, however, imposes friction and drag against the movement of the measuring element and so affects accuracy.

In addition, the separate intermediate gear train in conventional meters necessitates a stuffing box, and worn or faulty stuffing box packing and spindles are the cause of much present-day water meter maintenance.



Cutaway diagram shows:

1. *Heat treated register glass.*
2. *Hermetically sealed register which prevents condensation, keeps out water and dirt.*
3. *Magnetic drive.*
4. *Oscillating piston, the measuring element.*
5. *An O-ring gasket molded into the bottom plate liner to provide frost seal.*
6. *Interchangeable bottom plate of bronze or cast iron.*
7. *Measuring chamber which mates without screws.*
8. *Cast bronze case.*
9. *A large-area cylindrical strainer for unrestricted flow.*



Exterior view of the new sealed register water meter.

WHO'S RESPONSIBLE
if the paint finish fails?

No use pointing at one man or one department. When paint finish fails, there's trouble enough for everyone to have a piece of it. Costly rejects and spoilage in the plant; refinishing and reworking charges; lost production; expensive field service to take care of dealer and customer complaints.

Everyone agrees it's best not to have paint finish failures. That's why everyone from the president down so frequently demands Bonderite as the treatment used on metal before painting.

Bonderite is the original corrosion resistant paint base. It creates on metal surfaces an integral coating that's *friendly* to paint, that gives it a firm and lasting anchor. It resists corrosion and multiplies finish durability by three to five times.

Yes, best guarantee against paint finish failure on metal products is Bonderite. Full information and expert technical assistance is yours for the asking. Write or call today.

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corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

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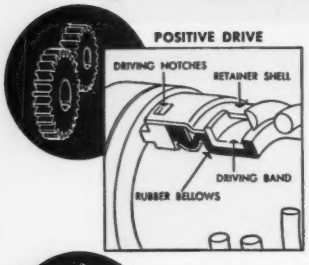
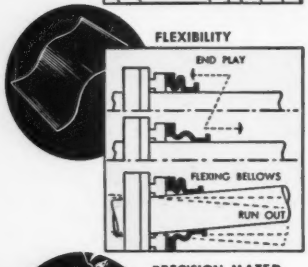


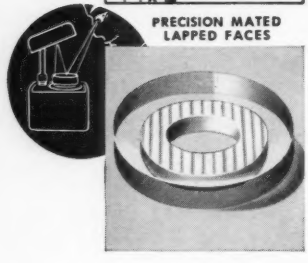
POSITIVE DRIVE

This gives long seal life. Drive is transmitted through the driving band and washer driving notch which absorb all breakout and running torque. Damaging stresses on the bellows or flexible sealing member are eliminated. Slippage is also eliminated, thus protecting shaft or sleeve against galling.



FLEXIBILITY

Axial and radial misalignment problems are eliminated. Self-adjusting bellows or sealing head automatically compensates for shaft end play or run out. Minimum spring pressure is required for axial shaft movement and uniform spring pressure is maintained during radial shaft movement.



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CRANE PACKING COMPANY

The crashable car

(continued from page 50)

This would show a continuous green-lit panel when everything is working properly, a red light in the pattern indicating some component out of order.

The windshield is far forward where it cannot be struck and has no curves sharp enough to give distortion. Rear passengers, one of whom faces aft, are retained by the conventional safety belts handed down by the aircraft industry. All seats are of the bucket type, to help control lateral motion in a sideways crash.

Bumpers completely ring the car and are set over material which will absorb blows rather than transmit them to the frame. They are shaped to promote glancing instead of direct impacts.

The ventilating scoops are part of the roof where they are less likely to feed carbon monoxide into the cab and the roof itself, completely padded, is strengthened against a rollover crash by built-in sheet metal stiffeners which play the same part as the roll bars in stock and racing cars.

The two remaining problems (providing easy access to an unusual seating arrangement and doors which won't fly open in a crash to jettison passengers onto an unyielding road surface) are both solved by the same device. The doors, only one on each side, operate on the folding principle of a streetcar door and run on tracks in the floor and roof. When shut, bolts prevent opening and give the structural strength to the cab "package" which is only maintained when the doors are closed.

All in all, it's a well-planned step toward passenger protection. If chances of an accident can't be reduced, at least the survival factor is raised in a car which offers safety features such as this and the Liberty-Cornell people are to be congratulated.

The Canadian figure for highway fatalities in 1956 alone was 3,183 killed, and the total rises annually. In spite of this situation here and in the States (where, in 1951, the country's millionth motor vehicle death was recorded) motor manufacturers make little more than a token gesture toward making their products a safe unit in a collision and, unfortunately, get little encouragement from the consumer.

What man, with a down payment in his pocket and a dream of chrome and painted steel before him, gives a fig for a safety feature? Like a parachute, it's useless when you don't need it: if you need and haven't got it—it's too late. ★

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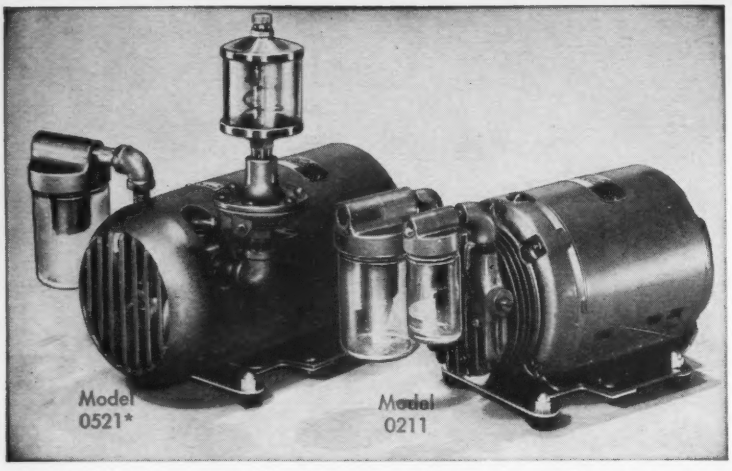

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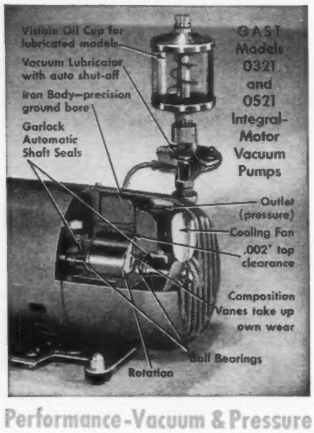
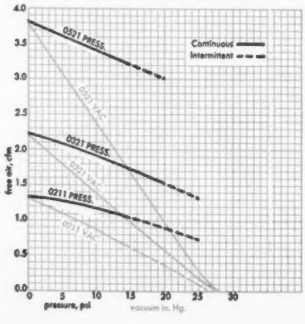
5. Simple, trouble-free rotary-vane design.
6. Vanes take up their own wear automatically.
7. Positive displacement, pulseless air delivery.
8. Improved appearance—smoother exterior.
9. Dependable for original equipment; plant use.
10. Forced air fan cooling on Models 0321 & 0521.



Performance-Vacuum & Pressure



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Spectography

(continued from page 61)

Since each atom excited in the discharge contributes equally to the exposure of the film, the concentration of an element may be assessed by determining the blackness of its particular emission lines. The densitometer is fitted with a photoelectric cell and sensitive galvanometer to convert light passed through the line into a reading of percent transmission. By means of analytical curves (previously prepared using standard samples) the readings may be related to percent concentration.

For laboratories devoted to the routine analysis of a large number of similar samples, direct reading spectrographs are now available that are almost fully automatic. The photographic film and the densitometer are replaced by photoelectric cells and an electronic recorder. Moments after the discharge has been completed, the concentration of elements may be read directly in percent from a chart.

Whenever a sample must be analyzed by wet-chemical methods, it is very helpful to the analyst to know what elements are present in the sample and what their approximate concentrations may be. With this data he can select the procedure, sample weight and quantity of reagents most suitable for the analysis. The spectrograph is particularly well suited to provide such comprehensive analytical data. In an hour's time, information may be obtained on even a few milligrams of sample, thus placing the elements present in concentration ranges that span factors of ten and overlap by factors of three, for example, 0.001 to 0.01%, 0.003 to 0.03% . . . 3 to 30% and 10 to 100%.

In trouble-shooting work, it is frequently found that the information from a preliminary spectrographic analysis is enough to solve a problem. In other cases, by pointing out missing or unsuspected elements, it often suggests profitable paths for further investigation.

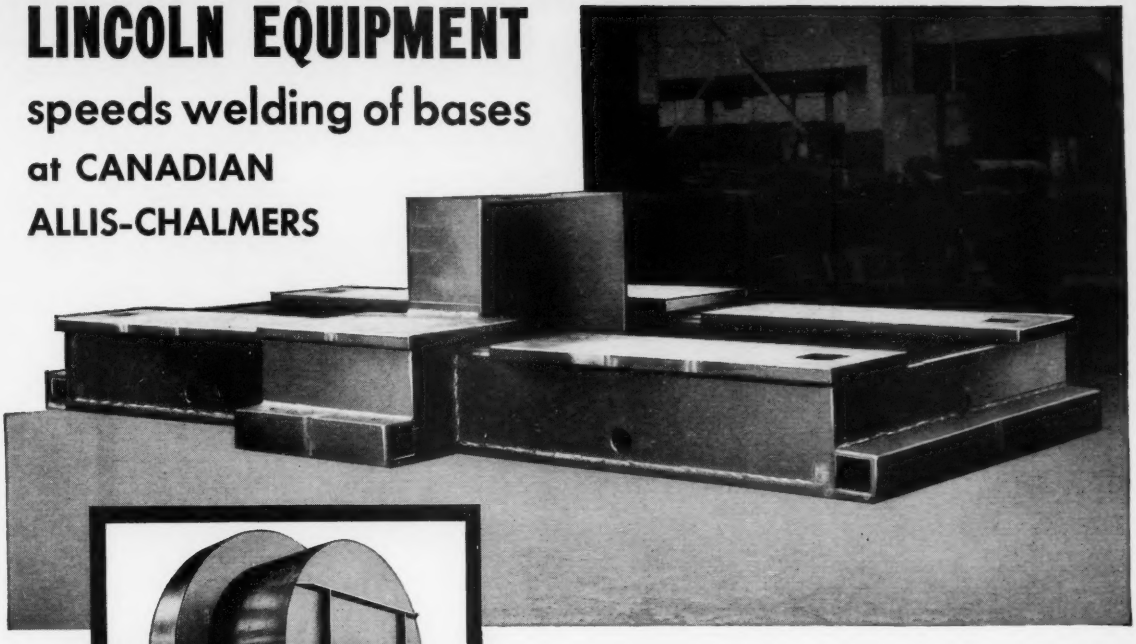
The spectrograph is equally useful in handling the numerous samples reaching the laboratory accompanied by the request, "What is the material?" It might be a speck of dust, or a massive casting, a sample of rock or a mysterious precipitate. The spectrochemical method can usually provide the answer with an economy of time and effort difficult to duplicate by any other means.

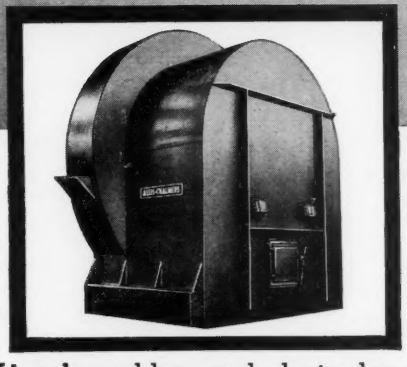
The sorting of mixed stock is another task readily performed by the instrument. For example, this laboratory on several occasions has been asked to separate mixed grades of electrical sheet steel. Two grades are possible, depending on the silicon content of the material. Samples of the various sheets are spectro-

Continued on page 88

LINCOLN EQUIPMENT

speeds welding of bases at CANADIAN ALLIS-CHALMERS





At Canadian Allis-Chalmers Ltd., Lachine, Que., where welded-construction is standard practice for bases, frames, hoods and other structural elements of heavy industrial machinery, **Lincoln** welders and electrodes are cutting costs and improving weld quality.

Since its introduction, **Lincoln Jetweld No. 2** electrode has speeded welding of final passes by 25%, cutting costs and minimizing distortion by virtue of rapid heat dissipation.

Lincoln heavy duty transformer-type AC welders are standard for much of the downhand welding at the plant. Welding speeds can be substantially boosted by using AC current on heavy weldments because it reduces the disadvantages of arc blow.

Welded construction can speed production, save materials, and improve strength. Write for the new 11th edition of the Procedure Handbook, available at cost. Also ask for free copy of **"Elements of WELDesign"**, issued quarterly, and particulars of **Lincoln's WELDesign Course.**

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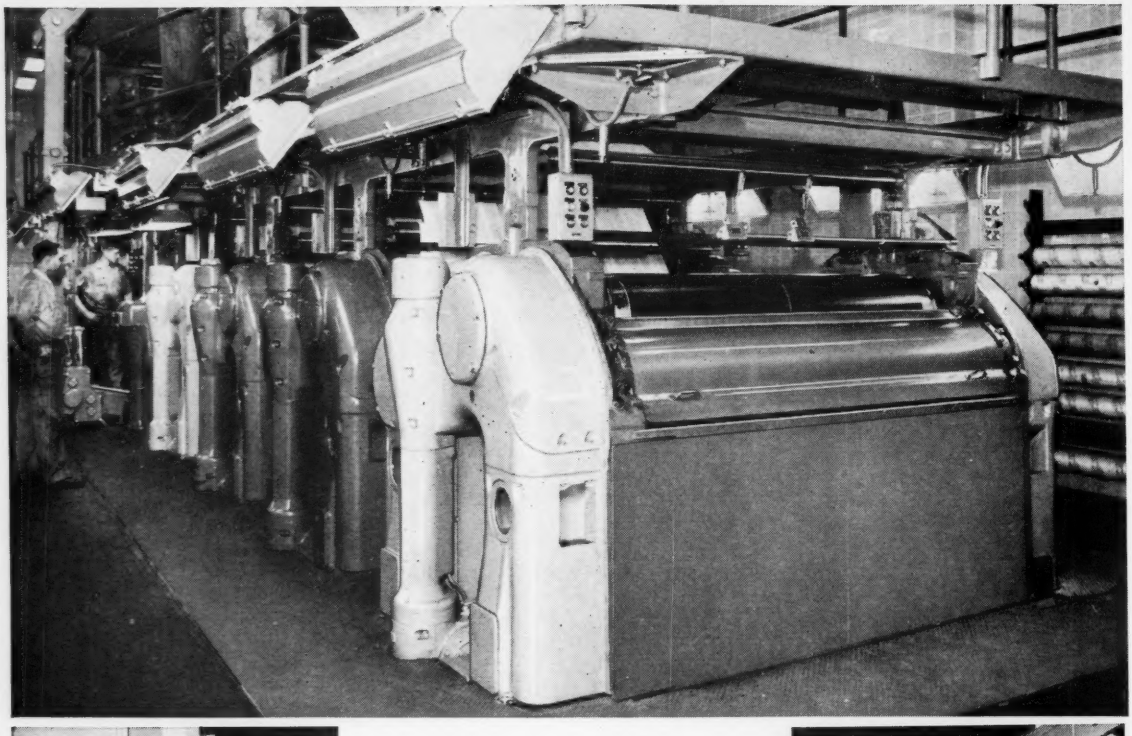
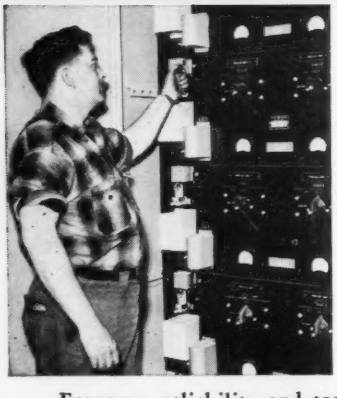
Winnipeg Tribune selects G-E DC Unit Drive

for efficient production . . . economical operation of new press

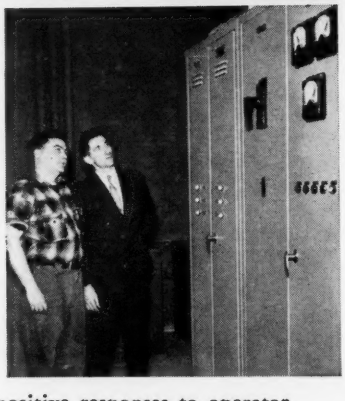




▲ The Winnipeg Tribune's new 7-unit Goss 'headliner' press produces 52,000 56-page copies per hour — with colour if required.

◀ The engineer is inspecting the interior of the selector switch cabinet. Selector switches for 7-units and 1 folder, thermal and instantaneous overload relays and ammeters shown.

Nerve centre controlling the electrical drive, of 7-unit, 1-folder printing press, consisting of a 300 KW Rectifier Cabinet and magnetic control cabinet. ▶



Economy, reliability and top performance at all running speeds were the main factors that led to the selection of a G-E Regulated DC Unit Press Drive for the Winnipeg Tribune's massive, new Goss press. Power costs are lower due to increased efficiency and an improved power factor . . . smoother running reduces web breakages . . . design simplicity cuts installation, operation and maintenance costs.

Clean air motor ventilation . . . absence of mechanical brakes and threading motors . . . the use of static control components contributes to the reliability of the drive. Smooth, stepless control from threading speed to top speed despite press load changes . . . positive responses to operator controls . . . these are the performance features of the G-E Regulated DC Unit Press Drive.

For the further details on G-E DC Drives, call your nearest C-G-E Sales Office, or write: Apparatus Department, Canadian General Electric Co. Ltd., Peterborough, Ontario.

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Spectrography

(Continued from page 82)

graphed together with one or two samples known to be representative of the grades involved. A simple visual comparison of the density of the spectral lines of silicon is all that is required to place the samples in their respective categories.

The full scope of spectrochemical analysis, however, is perhaps best illustrated in its application to the identification of corrosion products. In this type of problem, the amount of material available for analysis is usually very small. To compound the difficulty, the elements of interest may vary in concentration from major amounts to traces. Because of the great sensitivity of the spectrograph in detecting so many of the elements, useful information may be obtained even on milligram samples or less. The technique has been successfully applied in the elucidation of the corrosion process originating at grain boundaries in zinc alloys.

Although the spectrograph is commonly associated with the analysis of metals, its application to nonmetallic and organic samples can be equally important. The method has, in fact, been a valuable aid in solving paint and lubrication problems.

On one occasion there was reason to doubt whether a primer coat had actually been applied below a painted surface. Since the primer was known to contain lead, zinc and barium, the presence of these elements in the paint would be conclusive evidence of its use. To prove the point, a specimen was scraped from the painted surface and compared spectrographically with a sample of the primer. The similarity of the lines of lead, zinc and barium in the two spectra could not be disputed. There was no doubt then that the primer had been applied below the paint.

In lubricating problems, it is important to know whether the grease used was the correct type for a particular application. Spectrographic analysis can help to establish the type of grease by its soap base, as indicated by the concentration of sodium, calcium, lithium and potassium. Furthermore, the presence of impurities that may be shown in the analysis can be an important clue to the conditions causing the failure.

It is in routine quantitative analysis that spectrography has perhaps made its greatest contribution to industrial chemical analysis. Considerable time is required to determine the exact conditions under which the particular analysis must be made, but once the preliminary work has been completed, then samples may be analyzed in minutes instead of hours or days. And for elemental concentra-

tions at the level of 5% or less, the accuracy compares very well with that of wet-chemical methods. Unfortunately, at higher concentrations the spectrographic results gradually become less competitive.

Procedures have been established in this laboratory for the analysis of aluminum, solders and babbitts, and zinc-base die-casting alloys. Aluminum alloys are produced in the plant's foundry and require the determination of ten elements which range from 0.02 to 7%. Originally, the analysis was done wet-chemically, but as activity in the use of the metal increased, the Analytical Section soon became overburdened with work on this one type of sample. Transferring the analysis to the spectrograph solved the problem. Working time per sample was reduced nine-fold and a saving in analytical cost of $2,600 resulted in a two-month period.

Solders and babbits are used extensively in the electrical industry, so the analytical laboratory must consequently be prepared to carry out routine quality control analysis on samples from dozens of pots throughout the divisions. The spectrograph has been used economically in this service for over four years. An added advantage in this case is that nearly all the sample (when it meets specification) can be returned to the pot.

The analysis of the intricate zinc-base die-castings used in air-brake systems has also been transferred to the spectrograph. Using a polished surface of the casting as the sample specimen, major alloying constituents are first analyzed by a spark excitation, then the trace elements (lead, tin and cadmium) determined by an arc discharge. The nondestructive nature of the analysis is of particular importance, for the burn marks may be readily buffed out and the costly castings returned for use.

In summary, this article has introduced the reader to the general principles involved in spectrographic analysis and illustrated its scope and versatility by examples of its use at the Canadian Westinghouse Company Limited. The instrument has made a major contribution to industrial chemical analysis and is rightfully acknowledged as one of the most important analytical tools developed. ★

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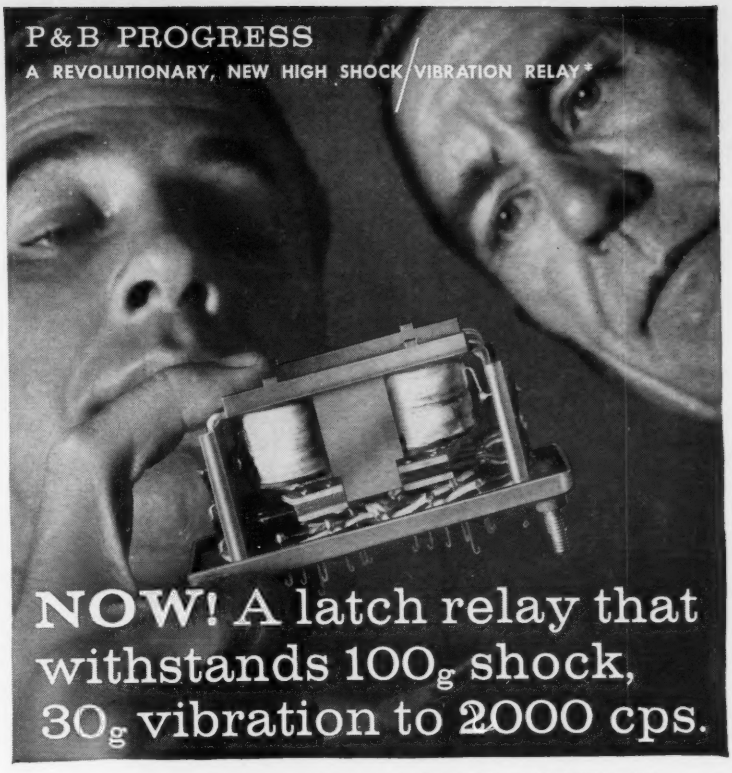
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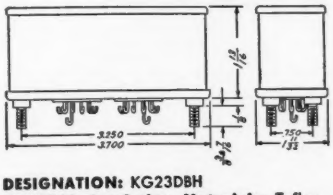

DESIGNATION: KG23DBH
GENERAL: Insulating Materials: Teflon, glass and ceramic.
Insulation Resistance: 100 megohms min.
Breakdown Voltage: 500 V. RMS.
Shock: 100g where contact openings less than 80 microseconds may be permitted.
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Weight: 13 ozs.
Pull-in-Speed: 12 MS using 310 ohm coil at 24 V. DC. (25°C).
Terminals: Two 11 pin multiple solder headers with hook ends for 3.20/AWG wires.
Enclosures: Hermetically sealed only.
Dimensions: 1-11/32 x 3.700 x .1-13/16 (See drawing for width, etc.)
CONTACTS: Arrangements: 6 pole double throw.
Load: Dry circuit to 3 amps, 115 V. AC, resistive. 5 amps, 28 V. DC, resistive.
COIL: Power: 2.0 watts at Nominal Voltage.
Duty: Either coil may be left energized without damage to the relay.
Insulation: Teflon tape.
MOUNTINGS: Four 3/8 inch #8-32 studs on 3¼ x ¾ inch centers.

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Quotes

Foundry facts

A standard collapsibility test for shell mold and core materials used with light metals is described in Foundry Facts, Issue No. 14 from General Electric Company's Chemical Materials Department.

The four-page illustrated brochure details the specifications and procedure for the test, which was recently formulated by the Light Metals Shell-Molding Committee of the American Foundrymen's Society.

Fatigue in metals

The inevitable deterioration of metals can be divided broadly into two types—actual physical wear and loss of initial strength of properties. The first type of deterioration, primarily due to friction and corrosion, can be prevented by controlling the design and operating environment of the metal parts, or by coating or lubrication. How long a material retains its initial properties, however, is something inherent in the particular base metal or alloy. Fatigue, creep and relaxation are indications of how well-suited a metal is to the operating stresses it will encounter in a particular application.

(From Bell Laboratories Record June 1957, by G. R. Gohn.)

Plastic blades

The aircraft gas turbine division of the General Electric Company first gave serious consideration to the use of reinforced plastics for compressor blading in the early part of 1952. At that time, the J-47 engine was in large-scale production and appeared to be the type of engine that would profit from the application of both plastic rotor and plastic stator blades. These profits would manifest themselves in the form of reductions in cost, weight and critical materials. The replacement of stainless steel by plastics results in a first order weight reduction. A second-order effect accrues from lower rim stresses in the rotor wheels, which in turn permits the use of either lighter metal wheels or radically different designs for compressor construction or both. The net gain here is in the increased payload of the aircraft. An economic survey based on specific production rates indicated a substantial cost reduction by using plastic blading. Critical materials reduction is difficult to estimate. There is little question, however, that in the event of an emergency, plastic blading in jet aircraft could save appreciable quantities of critical materials.

(From an article in the SPE Journal, June 1957 by John Kulp.)

Fan testing

When performed in accordance with accepted industry test codes, prototype testing is a reliable and approved procedure for rating air moving devices such as fans. The industry recommends and endorses such tests for the purpose of calculating performance data for a complete line of fans in a series and/or to verify the performance of a fan by means of a witness test.

The term "prototype fan" (as used here) designates a production fan unit which is tested to determine performance characteristics of fans of the same and larger sizes having the same design and geometrically similar proportions. The production fans for which calculations are being made must not be smaller in size than the prototype test fan.

Prototype fan testing is very useful whenever witness tests are required and especially in the case of a large unit, or whenever witness tests are required and and test facilities available. Performance data obtained by calculations from tests of a production prototype unit of smaller size has received wide acceptance by engineers and users.

(From Bulletin No. 151, published by the Air Moving and Conditioning Association, Inc.)

Steels for aircraft

There are five basic metallurgical requirements that must be met.

First (and perhaps the most important) is strength. A minimum tensile strength of 200,000 psi or higher will be necessary to meet design requirements, and the metal must maintain this strength throughout the range of temperature encountered in flight.

Second, the metal must have corrosion resisting properties. (Under certain conditions, this requirement may become less significant.)

The third requirement is producibility.

Fourth is availability in large tonnages and from numerous sources.

The final requirement is fabricability into finished assemblies, by equipment and skilled workmen in many plants.

The author, R. B. Gunia, of an article in Metal Progress, June 1957, expressed the view that steels best meet these new aircraft requirements.

Cam design

Practically all machine designers are confronted with the never-ending problem of running machines faster. Strong motivating factors in this direction are increased cost and competition. In a lecture at the Design Engineering Conference, Professor Harold A. Rothbart discussed industrial machines, particularly those fulfilling a function such as knitting, packaging, cigarette making and shoe making.

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Letters

Author Cunard replies:

The problem in question is the expansion of an elastic capsule from an original volume V_1 to a larger volume V_2. The expansion is caused by a change of the internal capsule pressure from the original pressure P_1 to P_2.

This increase of the internal pressure can only be caused—at constant temperature—by a quantity of gas entering the capsule through the pressure connection, which is clearly shown in the illustrations in the original article.

The work done in this compression process is represented by the area $V_{20}\,V_2\,P_2\,P_1$ when the kinetic energy of the gas entering the capsule is neglected. This is

$$\int_{P1}^{P2} V dp\,.$$

However, the original volume of the capsule V_1 expanded to V_2 because of the pressure change to P_2 as the capsule expanded elastically.

A surface element of the capsule with the area "a" moves on expansion over the distance ds and by doing so receives work of the force pa over the distance ds. This is work done by the pressure p to overcome the elastic forces until elastic forces hold the balance with pressure. The work done is $pads$ or $pdv\ ads = dv$.

The total work done by pressure on elastic deformation of the capsule is therefore

$$\int_{V1}^{V2} pdv\,.$$

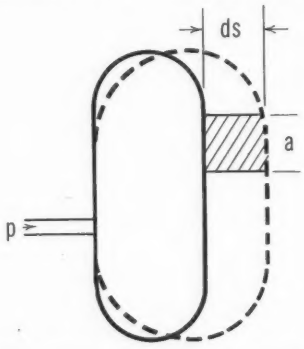
When the elastic deformation of the capsule is either restored by operation of a servo system or prevented altogether by using a stiff capsule or receiver, this integral

$$\int_{V1}^{V2} pdv$$

disappears, for $V_1 = V_2$ and only

$$\int_{P1}^{P2} Vdp$$

remains as expression for the work done, which is the area $V_{10}\,V_1\,P_2\,P_1$ in this case.



It is fair to assume that the process is isothermal, as the capsule volume is usually small and heat exchange is unrestricted. When the capsule volume does not change and for a perfect gas we can introduce the equation

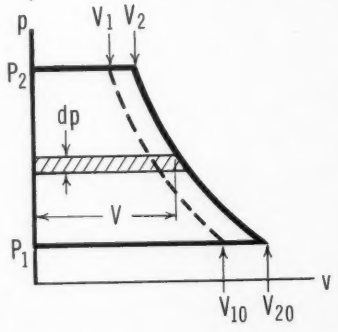
$$P_2 V_1 = pv = RT$$

and

$$T_1 = T_2 = \text{constant}$$

$$\int_{P1}^{P2} Vdp = \int_{P1}^{P2} \frac{RT}{p} dp$$

$$= RT \log_e \frac{P_2}{P_1} = P_2 V_1 \log_e \frac{P_2}{P_1}\,.$$



This last operation, which is given on request of Mr. Wilson, contributes nothing to the clarification of the problem except perhaps that it will further explain the values V_{10} and V_{20} of the compression diagram. V_{10} is the original gas volume at the pressure P_1 and temperature T_1, which after compression to the pressure P_2 and temperature $T_2 = T_1$, occupies the volume V_1. V_{20} is the original gas volume at P_1 and T_1 which under pressure P_2 occupies the volume V_2.

Finally the letter J is the complete energy equation:

$$Q = J\left(\int_{P1}^{P2} Vdp + \int_{V1}^{V2} Pdv\right)$$

is a constant factor. The value of J will depend upon the units which are used to measure Q, P and V.

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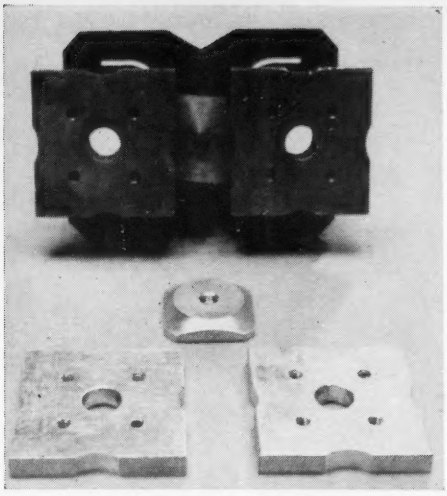

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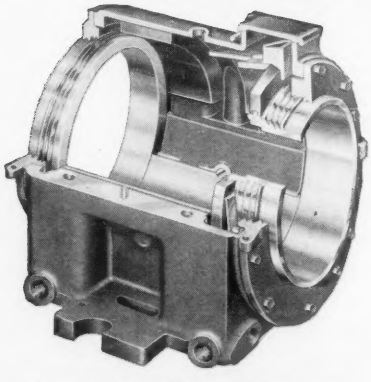

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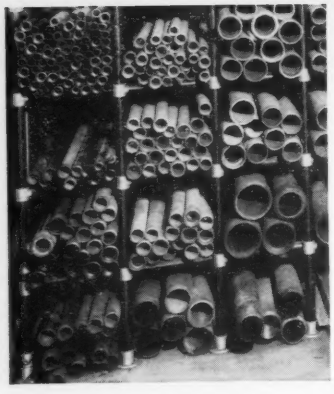

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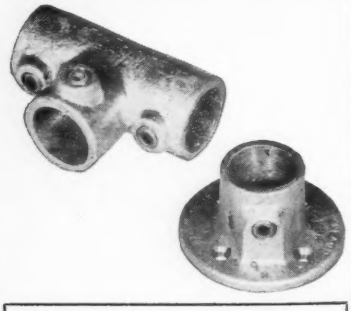

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Microscopy

(Continued from page 53)

transparent and opaque specimens. The furnace shell is water cooled in order to avoid damage to the microscope and is provided with a quartz observation window. The furnaces suitable for transparent specimens are provided with an additional quartz plate for illumination purposes. A low-voltage resistance heater is normally used in commercial furnaces. Correct design of the heater presents serious difficulties. When warmed up, the refractory liberates a considerable volume of absorbed gases. If the amount of the refractory is excessive, it takes a long time before an adequate vacuum is obtained and meanwhile the polished surface of the specimen may be attacked. For this reason, no insulating materials are used within the evacuated furnace chamber, the thermal insulation being provided by the vacuum. Radiant heaters composed of resistance wire, supported by a minimum amount of refractory, work quite well. The heater shell is shaped to screen the walls of the vacuum chamber and the observation windows from heat radiated by the coil and, at the same time, to direct most of the heat toward the specimen. To avoid any gases liberated by the refractory, and to improve the temperature gradient within the specimen in special furnaces, other heating methods have been used, including electron bombardment.

Most specimens give off some vapours at elevated temperatures. The vapours condensing on the comparatively cool observation window gradually form a semi-transparent film that seriously interferes with the clarity of the microscopic image. To collect the deposits, a screen with several aperatures, provided with very thin quartz plates, is interposed between the specimen and the observation window. Vapours condense on the plates and the window remains clear. When condensation becomes excessive, the screen is rotated by means of an external magnet until the next clean plate comes into the path of the light.

The temperature of the specimen is measured by a thermocouple, the sheath of which is used as the specimen support. This system of specimen support reduces errors of temperature measurement to an acceptable level. In some older commercial stage furnaces designed for use with inverted metallographic microscopes, the hot junction of the thermocouple was located in a small hole drilled in the specimen. Although accuracy was very good, the thermocouple was not easy to install and was readily contaminated. The type of temperature indicator is unimportant, provided the instrument is sufficiently accurate. If automatic temperature control is used, a fast electronic potentiometer is preferable, as low heat capacity of the radiant heater and the location of the thermocouple make a good control complicated and difficult.

When very high temperatures (well over 1000 C) are required or where large specimens must be examined, a standard microscope fitted with a stage furnace is unsuitable. Heat radiated by the specimen surface will ruin the precise optical system of any microscope, and the heavy, complicated and large furnace cannot be accommodated on the stage. It becomes essential to place the microscope a considerable distance from the furnace and this is accomplished by the addition of an optical relay system. The relay system (usually a special lens of several inches focal length) produces a real image of the examined surface, generally of natural size, at a safe distance from the furnace observation window. The image is then examined through a microscope of conventional design and recorded photographically.

A high temperature furnace satisfying all the requirements of microscopy becomes a precision instrument and may be considered as the principal component of a good furnace-microscope assembly. Consequently the auxiliaries required to operate such a furnace are complicated, even more so than those used with stage-furnaces. For work at very high temperatures, even an optical temperature measuring device may have to be incorporated in the assembly as an integral component of the optical system. Complete instruments built as a unit and composed of a furnace (with auxiliaries), an illuminating system and an optical system (including matched sets of relay lenses and microscope objectives) are produced by only a few manufacturers. So far, the range of magnification obtainable with a good resolution is limited to about 100 to 200 dia. In the lowest range of magnification frequently used for examination of large specimens, usable results may be obtained even with instruments built from inexpensive components. When resolution of fine detail is not at a premium and sub-standard photo-recording may be tolerated, a good photo-objective substituted for a proper relay lens and a standard microscope fitted with a low power objective form an adequate optical system.

Illumination of the specimen at low temperatures and flicker at high temperatures remain as difficulties even in the lowest magnification range.

A unit composed entirely of standard (and comparatively inexpensive) optical components is shown in Fig. 3.

The high quality of microphotographs obtainable with the stage furnace microscope may be appreciated from Figs. 4 & 5. ★

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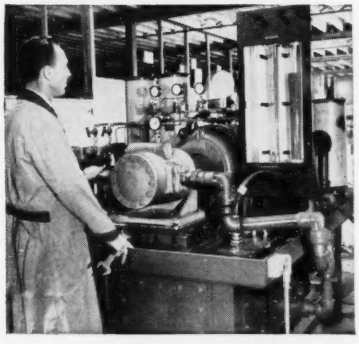

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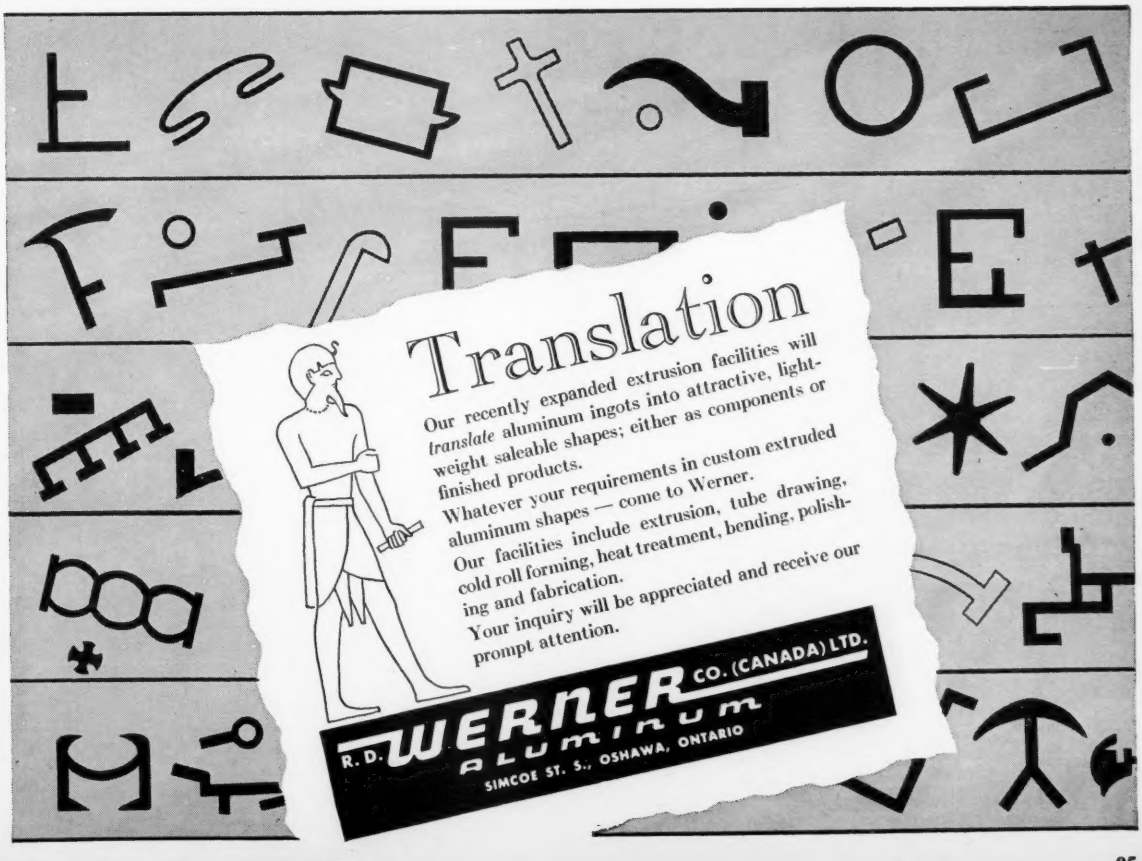
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Rubber in Engineering. The conference on Rubber in Engineering (organized by The National Rubber Development Board) could only cater for a fraction of those interested in the growing possibilities of rubber as an engineering material. The board has therefore published the proceedings in book form (including all five papers and the discussions they inspired) to make the information generally available. The book is a companion volume to "What Every Engineer Should Know About Rubber" and "Rubber in Automobile Engineering."

The five papers are: "Rubber Must be Used Correctly," by W. J. S. Naunton, MA (Cantab); "Load-Deflection Relations and Surface Strain Distributions for Flat Rubber Pads," by A. N. Gent, BSc, PhD; "The Use of Rubber in Heavy Engineering," by S. W. Marsh, MILoE; "Dynamic Fatigue Lime of Rubber Components," by P. W. Turner, MA, BSc; and "Rubber in Agriculture," by S. J. Wright, MA.

American Institute of Physics Handbook. This book (published by McGraw-Hill) fills the long-felt want for an all-inclusive reference work, similar to the comprehensive volumes available to scientists and engineers in other fields. In it will be found a wide range of tables, graphs and summaries of formulas in all fields of physics. Much of the material is otherwise available only in scattered reference works and research reports.

Over a hundred subject areas are covered in the eight sections of the book; mathematics, mechanics, heat, sound, electricity and magnetism, optics, atomic and molecular physics, and nuclear physics. Each subsection is the work of one or more specialists in that field. Highly authoritative and dependable information is offered in all sections of the book.

Typical of the wide scope of information are the following topics, representing data that is particularly new, or unusual or not easily accessible elsewhere: geophysical data; rheological data; flow of gases, taking account of important developments in aerodynamics; shock waves; high pressure effects; values of the electronic constant in the low temperature heat capacity of metals (including superconductors); thermal conductivity at very low temperatures; hitherto unpublished material and concepts on analogies, in the acoustics section. The book is priced at $18.00.

Surface Treatment of Metals. As a supplier of a wide range of products for surface treatment, E. F. Houghton & Co. have accumulated many years of experience in this special field. The purpose of this handbook is to present helpful and pertinent information on various surface treatments and processes, based on this experience.

In recent years, the attention of the metal industry has been focused increasingly on the surface treatment of metals.

In many cases, surface treatment has a direct bearing on the sales appeal, durability or performance of a product. Also, proper surface treatment can often help streamline and cut the cost of production. With today's high labor cost, this can result in sizable savings.

Cleaning — one of the basic steps in the surface treatment of metal parts — provides an example of cost saving by using modern methods. Formerly, it was almost standard to employ hot cleaning baths which called for heating systems, fuel, controls and special ventilation, all of which increased costs. Today, much of this cleaning can be accomplished quickly, effectively and economically with room temperature cleaning compounds that require no special equipment or added operating costs.

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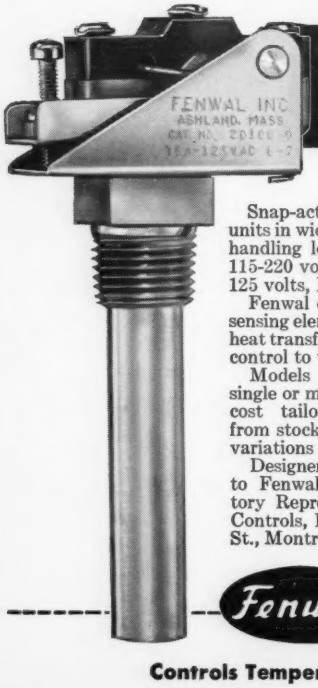

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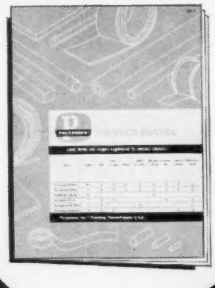

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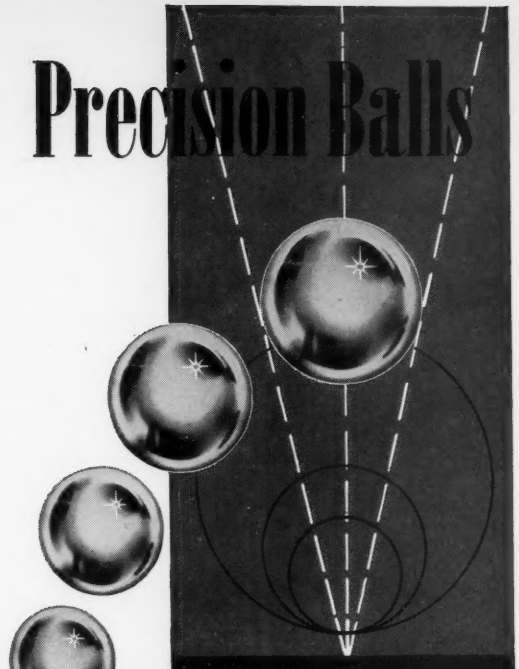

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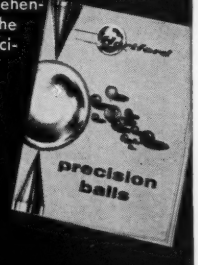

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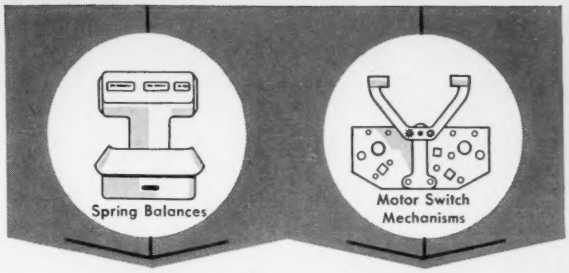

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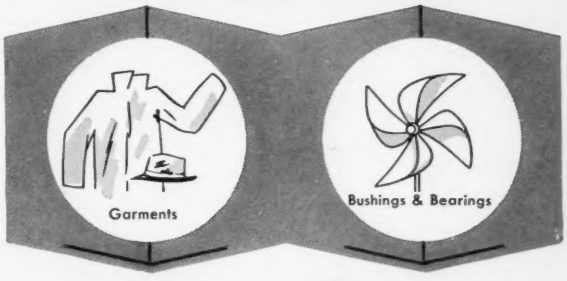

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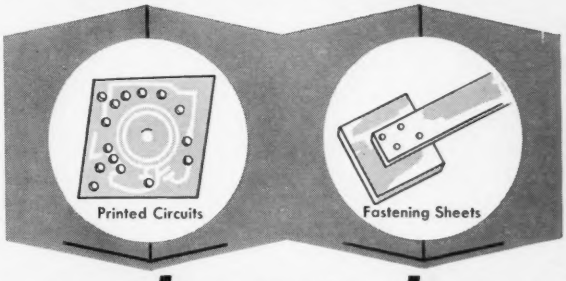

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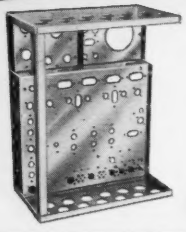
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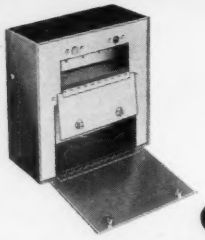
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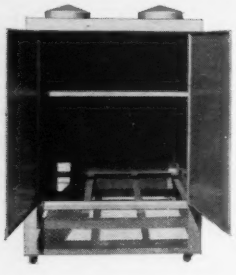
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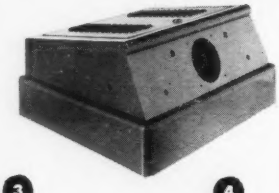
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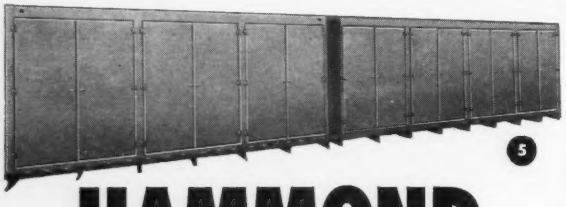
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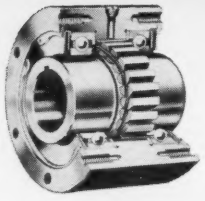

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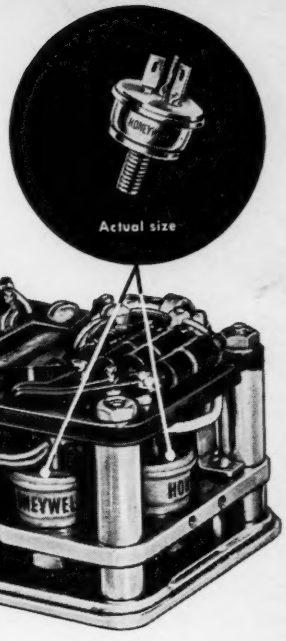

Honeywell Weld-Seal H6 Transistors make this 48-watt, 12 oz., D.C. power converter more compact than any other.

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- *Voltage Regulation*

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Honeywell Weld-Seal Transistors offer a narrow span of characteristics—*plus* superior electrical performance and high uniform power gain over a wide range of collector current values; and have a maximum emitter current, R.M.S. of 3.5 amps.

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Editorial

A noteworthy Canadian achievement

Everyone concerned with the development of the Iroquois turbojet engine, which had its first public showing at Malton last month, is deserving of the warmest praise.

We heartily agree with Walter R. McLachlan, president and general manager of Orenda Engines Ltd., when he stated in his address to the august assembly: "I suggest to you that a challenge such as the design and production of the Iroquois engine is a terrific stimulus to our brilliant young Canadians. If we can tackle and succeed in a task like this, involving very advanced thinking in physics, metallurgy, electronics and mechanical design, we do not need to say we can't design in Canada." Indeed we don't!

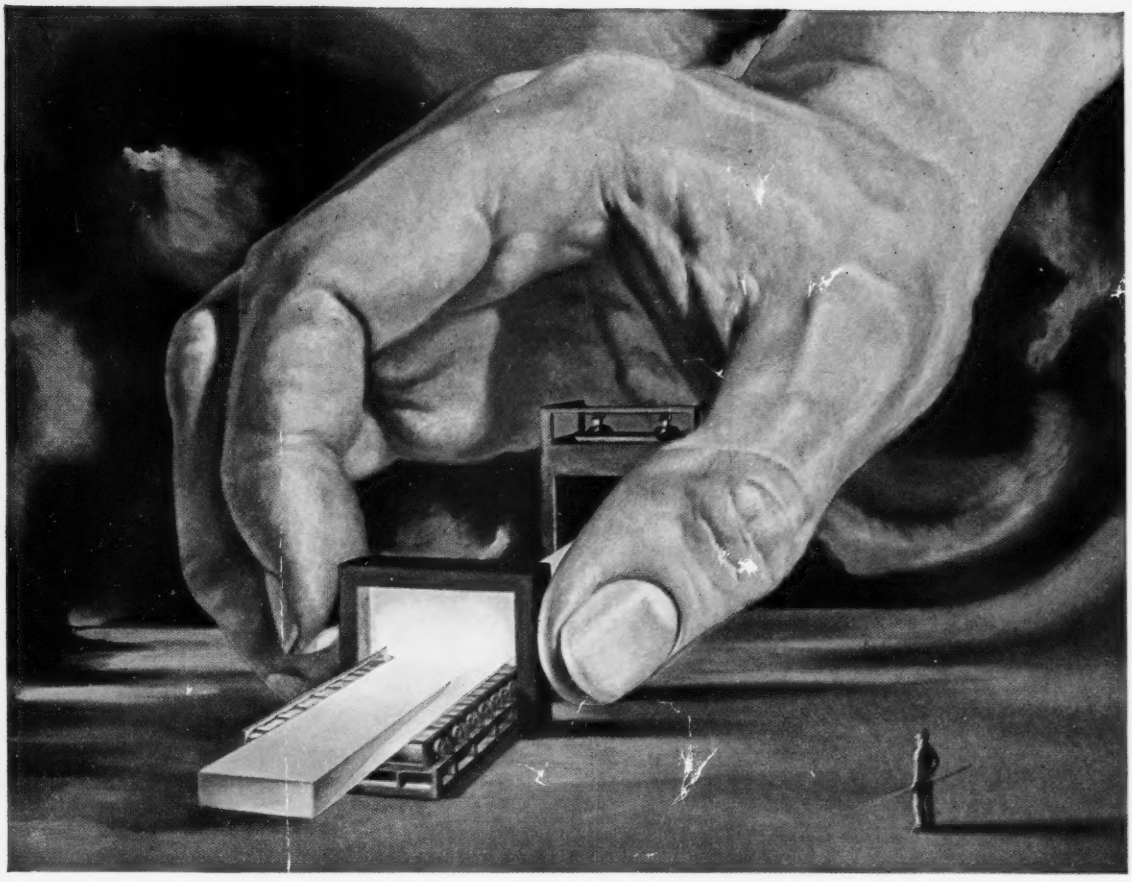
Some of the interesting facts gleaned from his address are that the Orenda engine (the forerunner of the Iroquois), which powers the CF-100 and the Sabre, is 95% Canadian in content. For every pound of engine weight the Chinook (the first jet engine to be designed and built in Canada) gave only 1½ lb of thrust, compared with which the Orenda gave 3 lb while the Iroquois gives 5 lb. So rapid, in fact, has been the technical development that in seven years the Iroquois can give nearly four times the power per pound of engine weight.

All this has given impetus also to the development of titanium, a metal with the same strength as steel but only 60% of its weight.

As Mr. McLachlan said: "It is only very recently that it has been recognized that we are competent in the field of mechanical design, and even more recently that we can make a contribution in the field of aeronautical engineering."

There is no longer any doubt in our minds about the ability to carry out original design work in Canada. We only hope that full use will be made of the opportunities that exist for it.

William Morse.



Surface defects disappear when oxygen and acetylene team up to provide a

Smooth, Flawless Skin . . . for Steel

YOU KNOW the steel in your automobile and refrigerator is smooth and perfect.

BUT DID YOU KNOW that to get these smooth, flawless surfaces the steel had to be 'conditioned'? This means removing the rough scale and surface defects that form on the steel ingots as the molten metal cools.

To remove these defects by hand methods required further cooling of the steel. This was a costly and time-consuming process—a bottleneck to steel production.

THROUGH BLAZING HEAT—Today, as steel travels through the mill, it passes through the 6,000-degree heat of oxy-acetylene flames. Then, while still moving at speeds up to 130-feet per minute, streams of pure oxygen are directed against its blazing hot surfaces. The scaly scarred surfaces are instantly burned away.

The slab emerges clean—ready to be rolled into flawless sheets for your car, refrigerator, and many other useful products that serve you.

ANOTHER JOB OF UCC—Producing oxygen and acetylene for this and many other uses is one of the important jobs of the people of Union Carbide. It is one more way in which they transform the elements of nature for the benefit of all.

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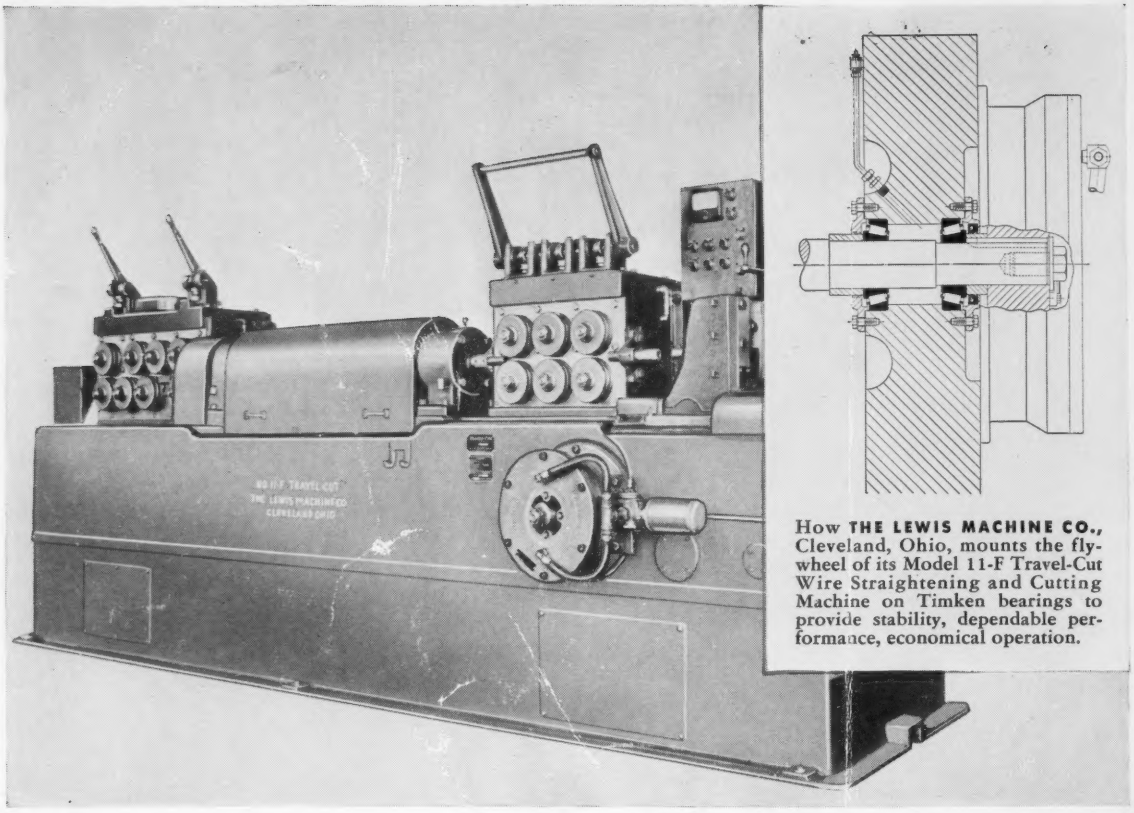

How **THE LEWIS MACHINE CO.**, Cleveland, Ohio, mounts the flywheel of its Model 11-F Travel-Cut Wire Straightening and Cutting Machine on Timken bearings to provide stability, dependable performance, economical operation.

How TIMKEN bearings keep flywheel stable on automatic wire straightening and cutting machine

TO take the varying loads of automatic wire straightening and cutting, the bearings in this Lewis Model 11-F Travel-Cut have to be extra tough and virtually friction-free. That's why The Lewis Machine Company uses Timken tapered roller bearings for the flywheel, feed rolls and drive—38 in all. Timken bearings keep the flywheel stable and rotating freely, position gears and feed rolls accurately even under heavy loads.

EXTRA LOAD-CARRYING CAPACITY. Full line contact between their rollers and races gives Timken bearings extra load-carrying capacity. Tapered design lets Timken bearings take *both* radial and thrust loads in any combination. The flywheel doesn't wobble. Gears and feed rolls *stay* in position.

PRACTICALLY FRICTION-FREE PERFORMANCE. Because they're geometrically designed to roll true, and precision-made to live up to their design, Timken bearings virtually eliminate friction. They run smoother, last longer.

NO SHOCK PROBLEMS. Because they're case-carburized, Timken bearings' rollers and races have a hard, wear-resistant surface over a tough, shock-resistant core. They *absorb* shocks, reduce maintenance.

That's why it pays to specify bearings trade-marked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio, U. S. A. **CANADIAN PLANT:** St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN *Made in* **CANADA**

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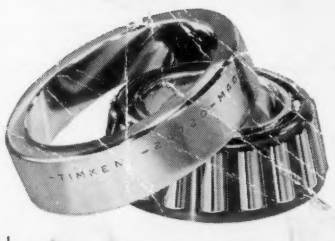
FOR CANADIAN INDUSTRY



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST —◫— LOADS OR ANY COMBINATION —◫—